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ANNUAL REPORT

OF THE

PROGRESS OF CHEMISTRY,

And the Allied Sciences,

PHYSICS, MINERALOGY, AND GEOLOGY;

Including the applications of Chemistry to Pharmacy, Medicine, Agriculture, the Arts and Manufactures:

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VOLUME II. 1847—1848.

LONDON:

TAYLOR, WALTON, AND MABERLY,

UPPER GOWER STREET, & IVY LANE, PATERNOSTER ROW.

MDCCCL.

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LONDON:
Printed by Schulze and Co., 13, Poland Street.

PREFACE.

Chemistry, theoretical and technical, Physics, Mineralogy and Geology, are so closely allied as to render it impossible to separate them by lines of accurate demarcation, or to select any of them as a subject of special study without reference to the rest. On the other hand, the immense magnitude of the field occupied by these sciences, and its rapid extension by the annually increasing number of their cultivators, render it difficult for individuals to survey its vast area. To facilitate this survey, to promote a clear perception of the actual progress of these sciences, was the object of the present Report, which is the result of the friendly co-operation of a number of teachers in the University of Giessen. We are indebted to Professor Buff for the Report on Molecular Actions, Electricity, and for part of that on Magnetism; Professor Zamminer undertook to report upon Diamagnetism, Kinetics, Acoustics, Optics, and part of Thermology; Professor Will upon part of Chemistry; Professor Knapp upon Technical Chemistry; Professor Ettling upon Mineralogy; lastly, Professor Dieffenbach upon Chemical Geology.

The Report aims at completeness as far as is compatible with the limits, which in a work of this kind cannot be overstepped without swelling it beyond legitimate dimensions, and rendering it thus less accessible. Now although in general the abstracts given will be found sufficiently elaborate to render it unnecessary for the reader

to turn to the original memoirs, still it is obvious that many cases must occur in which, for special purposes, the inspection of the original sources may be desirable. On this account particular attention has been paid to the accuracy of the literary references; not only the original papers, but also any translations or abstracts in other journals, which may be more detailed than that in the Report, have been cited as additional references.

The present work attempts to relate the progress of our knowledge in several branches of inquiry of which it is difficult to assert that they belong to one of the above sciences, rather than to some other department of natural research; in such cases a complete conspectus was possible only from one point of view: thus, mathematico-physical inquiries could but be elucidated chiefly by a delineation of their physical foundation and their physical results. Again, the communication of the chemico-physiological researches, was, of necessity, limited to a complete synopsis of the papers contained in the Chemical Journals.

The Report endeavours to reproduce, as faithfully as possible, the separate investigations, without, however, excluding a fair criticism by the Reporter. Whoever is acquainted with the actual condition of Chemistry, must admit that this science, in all that relates to the fundamental views respecting the constitution of salts, and of organic compounds, is at present in a state of transition. We are not sufficiently advanced to perceive which are the correct views, and which will be ultimately and permanently adopted. On this account it became a special duty to report upon the *various* theories which are now in process of elaboration. It appeared desirable to represent the different researches, as far as possible, according to the conception of their authors, instead of discussing them from the point of view of a particular school, which might be anxious to indicate their accordance, or to explain their discrepancy, with its favourite doctrines.

It need scarcely be mentioned, that this method of reporting could not positively be carried out in every detail without giving rise to many evils which would considerably diminish its general advan-

tages. It would have been highly inconvenient to reproduce in the communication of separate researches the discordant views entertained by chemists as to equivalents, and their different modes of writing chemical formulæ; much valuable space would have been lost by repeated explanations, and great confusion and obscurity caused, unless one notation had been chosen for the formulæ and adhered to throughout. This has been done, and the perspicuity of the symbols insured, by the appended synopsis of the equivalents adopted in the work. Whenever the symbols are intended to represent values different from those in general use, the attention of the reader is specially called to this change; thus, in the Mineralogical Report, silicic acid, usually represented by SiO_3, in the comparison of the various formulæ of the same mineral, is sometimes expressed by SiO_2, when Si acquires a different value. In no case, however, will the reader have the slightest difficulty in knowing which equivalent of silicium is assumed. Nor is any mistake to be anticipated from the fact of the symbols of elements, replacing each other in variable proportions, being used sometimes rather in their qualitative, than in their strictly quantitative signification, a mode of use which is invariably indicated by the symbols concerned being enclosed in brackets; thus (MgO, CaO, FeO), CO_2 represents a compound RO, CO_2, in which RO expresses magnesia together with lime and protoxide of iron.

All temperatures, unless otherwise stated, are noted in degrees of the centigrade scale.*

* The centigrade thermometer has been retained in the English edition of the Annual Report. The advantages of an uniform mode of stating temperatures is so evident, that the adoption of the centigrade scale in scientific language is gradually becoming universal on the continent, even in countries where, as is the case in Germany, another scale is used for the purposes of common life. To facilitate the conversion of the various scales, a very complete table has been appended.

As the majority of the weights and measures quoted represent only relative magnitudes, the decimal system, so incomparably superior to every other, both in simplicity and convenience, has been, with but few exceptions, retained from the original Report.

The present Report extending over the two years 1847 and 1848, its size has been doubled and its appearance retarded; each future Report will be limited to one year, whereby a regular and early publication will be insured.

J. LIEBIG, H. KOPP.

In a few instances in which absolute magnitudes of practical interest are concerned, the corresponding values in the English scales have been inserted; we have given, moreover, tables for comparison, by the aid of which the conversions in every special case may be effected.—EDS.

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ORGANIC CHEMISTRY.

(CONTINUED.)

Alcohols and Collateral Matters. Methyl-Compounds and their Correlatives. Crude Wood-spirit. New Body contained therein. — From crude wood-spirit Scanlan, and afterwards Gregory, obtained a substance crystallizing in yellow needles; the former termed it eblanin, the latter pyroxanthin; Gregory(1) prepared it by saturating the first product of the distillation of crude wood-spirit with lime, distilling, extracting the residue with hydrochloric acid, and subsequently with small portions of alcohol, which first dissolves out a resin, and finally pyroxanthin. Schweizer(2) obtained the same body by subjecting crude wood-spirit to fractional distillation in the water-bath, collecting separately the product when it had nearly ceased to be inflammable, and saturating the distillate with potassa. A chrome-yellow precipitate was quickly formed, which, when repeatedly treated with small portions of boiling alcohol, yielded, at first a resin, and subsequently pyroxanthin. The liquid from which the pyroxanthin was obtained, by means of potassa, being colourless, while even a dilute solution of pyroxanthin exhibits an intensely yellow colour, Schweizer considered it probable that pyroxanthin might be formed only by the action of the potassa upon a peculiar body contained in the liquid. He succeeded in isolating the latter compound, by allowing the above-mentioned fluid product of the distillation of crude wood-spirit to stand, for twenty-four hours, in contact with excess of ether, the mixture being frequently agitated, and distilling the ethereal layer, when a heavy, brownish oil remained, which was repeatedly washed with water, then separated from a dark-brown resin, by distillation

Methyl-compounds and their correlatives. Crude wood-spirit. New body contained therein.

(1) Ann. Ch. Pharm. XXI, 143.

(2) Fom Nr. 21 der Mittheil. der Naturforsch. Gesellsch. in Zürich, in J. Pr. Chem. XLIV, 129.

Crude wood-spirit. New body contained therein.

with water, and once more rectified with water. In this manner he obtained a fluid, which is heavier than water, of a disagreeable odour, resembling that of smoked fish, and of an acrid taste; it is difficultly but entirely soluble in water, and partially separates from a hot saturated solution on cooling; it is readily soluble in pyroxylic spirit, alcohol and ether, and cannot be distilled alone without considerable decomposition. This liquid gradually assumes a yellow colour, especially when exposed to the influence of light and air; at -28^0 it solidifies to a white fatty mass. When treated, either in an aqueous or alcoholic solution, with potassa, baryta and lime, it yields pyroxanthin; assisted by heat, the carbonates of the alkalies produce the same effect, as does ammonia, which gives rise to the formation of pyroxanthin after several hours in the cold, and in a few minutes at the temperature of ebullition. In this decomposition, together with pyroxanthin, are formed an indifferent resin, and a volatile acid, which readily and completely reduces salts of suboxide of mercury.

Action of Chlorine upon Wood-Spirit.—Bouis(1) has investigated the action of chlorine upon (pure?) wood-spirit. Dry chlorine is absorbed by wood-spirit in diffused light; the liquid becomes hot, and of a transitory rose-red colour with evolution of hydrochloric acid, of a gas burning with a green flame, and subsequently of carbonic acid. If the process be interrupted as soon as an oily layer separates at the bottom of the vessel, a large quantity of hollow crystals are found, after some hours, resembling those of chloride of sodium; the layer of oily fluid in which they have been formed, when exposed to the air in a shallow vessel, solidifies with evolution of a powerful odour which irritates the eyes. The crystals are insoluble in water, readily soluble in alcohol and ether, unalterable in the air, and volatile; like benzoic acid they may be sublimed through unsized paper, and then present the form of long prismatic needles. They fuse at about 50^0, and commence to boil at about 75^0, but the boiling-point continually rises. Their composition is represented by the formula $C_{10}\,H_{10}\,Cl_2\,O_4$. Bouis believes that this compound which he designates *chloromésitate de méthylène*, originates from *methylal* $C_6\,H_8\,O_4$,

$$2\,C_6\,H_8\,O_4 + Cl_8 = C_{10}\,H_{10}\,Cl_2\,O_4 + 2\,CO_2 + 6\,HCl;$$

and that methylal may be either formed from wood-spirit when acted upon by chlorine

$$3\,C_2\,H_4\,O_2 + Cl_2 = C_6\,H_8\,O_4 + 2\,HCl + 2\,HO,$$

(1) Ann. Ch. Phys. [3] XXI, 111; J. Pr. Chem. XLII, 301; Compt. Rend. XXV, 256, (in abstr.); Ann. Ch. Pharm. LXIV, 316.

Action of chlorine upon wood-spirit.

or that it possibly may be contained in commercial wood-spirit which is of so variable a composition, and so difficult to purify. The above-mentioned crystals appear to be attacked only with difficulty by potassa and ammonia; nitric acid dissolves them; they yield with sulphuric acid a solution, which after a time becomes of a beautiful rose-red colour, but immediately turns black when gently heated. Dry chlorine has no action upon the dry crystals in diffused light; exposed to solar irradiation, however, they rapidly absorb this gas with formation of an oily liquid, of a suffocating odour, insoluble in water and soluble in alcohol and ether.—By the continued action of chlorine upon wood-spirit, the crystals which have been formed again disappear, and the whole liquid becomes oily. As the final product, an oily liquid was obtained, which, when washed and dried, exhibited a composition corresponding to the formula $C_6\ H_3\ Cl_3\ O_2$. This oily liquid (the vapour of which powerfully irritates the eyes, and acts as a caustic upon the skin), when exposed to the air, previously to its being washed, is converted into white, nacreous crystals, which are readily soluble in water, alcohol and ether; the aqueous solution of this substance, which is not precipitated by nitrate of protoxide of silver, deposits large and well-formed crystals, exhibiting but a feeble odour when thus obtained. These crystals fuse towards 35°, they commence boiling at about 90°, and are decomposed while the boiling-point rises. Their composition is expressed by the formula $C_6\ H_2\ Cl_4\ O_2 + 8\ HO$. They are violently attacked by the alkalies. They effloresce, *in vacuo*, with loss of water; when distilled with anhydrous phosphoric acid they yield a colourless volatile liquid $C_6\ H_2\ Cl_4\ O_2$, which, when exposed to the air becomes crystalline, with absorption of water. The compounds $C_6\ H_3\ Cl_3\ O_2$ and $C_6\ H_2\ Cl_4\ O_2$, may be regarded as acetone, in which hydrogen is replaced by chlorine.

Methyl.—With regard to a body of the composition of the hypothetical methyl, comp. "Decomposition of cyanide of ethyl by potassium."

Iodide of Methyl.—According to Pierre(1) iodide of methyl ($C_2\ H_3\ I$) is not attacked by a current of hydrochloric acid to which it is submitted; if chlorine be slowly passed through iodide of methyl, covered with a stratum of water, and placed in a feebly-

(1) From the Recueil des Trav. de la Soc. d'Émulat. pour les Sc. Pharm., July, 1847, 3, in J. Pharm. [3] XIII, 156.

Bromide of methyl.

lighted room, the liquid immediately becomes brown, pure chloride of methyl gas ($C_2 H_3 Cl$) being evolved with separation of iodine.

Bromide of Methyl.—Pierre(1) has likewise investigated bromide of methyl ($C_2 H_3 Br$). 50 parts, by weight, of bromine, are cautiously (in small portions) dissolved in 200 parts of purified wood-spirit, at a temperature from 5° to 6°, direct sunlight being carefully excluded; 7 parts of phosphorus are then slowly added to it in a tubulated retort at a temperature below 5°; on gradually heating in a water-bath, the action commences at 7° to 8° when heat sufficient for the fusion of the phosphorus is evolved. As soon as the liquid has cooled, the straw-yellow layer which has separated, is removed, and cautiously distilled together with the portion which had previously passed over; the distillate is washed at 0°, first, with very slightly alkaline, and then with pure water; dried at 0° with chloride of calcium, and rectified in a water-bath at a temperature not exceeding 21° to 22°. A colourless, neutral, strongly odorous liquid is then obtained, of a spec. grav. 1·664, boiling at about 15°, under a bar. pressure of 759^{mm}, and remaining transparent and fluid even at —35°·5. Analysis agrees with the formula $C_2 H_3 Br$.

Cyanide of Methyl.—For cyanide of methyl and its decomposition by hydrate of potassa we refer to I. 420; respecting its formation, *see* "Nitriles," I. 456.

Action of Nitric Acid upon Sulphocyanide of Methyl. Hyposulphomethylic Acid.—J. S. Muspratt(2) has found that sulphocyanide of methyl $C_4 H_3 S_2 N$, which is obtained as a heavy oily liquid of a disagreeable garlic-odour, by distilling, in a capacious retort, equal volumes of saturated solutions of sulphomethylate of lime and sulphocyanide of potassium, yields, with strong nitric acid, *hyposulphomethylic acid*, the acid which Kolbe obtained from chlorocarbohyposulphuric acid, $C_2 Cl_3 S_2 O_5$, + 5 HO, by exposing it in contact with zinc to the action of an electric current. For a description of the method of preparing the acid and the salts, we refer to the statement respecting hyposulphethylic acid (*v. infra*). Hyposulphomethylic acid is inodorous, and withstands a high temperature without decomposition.—The baryta-salt is readily soluble in water, and is precipitated from this solution by spirits of wine; when dried *in vacuo* its formula is $BaO, C_2 H_3 S_2 O_5 + HO$ (HO is

(1) From the Recueil des Trav. de la Soc. d'Émulat. pour les Sc. Pharm., October, 1847, 172, in J. Pharm. [3] XIII, 157.

(2) Chem. Soc. Qu. J. I, 45; Ann. Ch. Pharm. LXV, 251; J. Pharm. [3] XIII, 302.

evolved at 100°).—The lead-salt crystallizes from the aqueous solution in fine rhombic prisms, $PbO, C_2 H_3 S_2 O_5 + HO$; on heating, the water is evolved with intumescence.—The copper-salt is obtained in splendid crystals, $CuO, C_2 H_3 S_2 O_5 + 5 HO$, by slowly evaporating the aqueous solution.

Action of nitric acid upon bisulphide of methyl. Sulphomethylo-sulphuric acid.

Action of Nitric Acid upon Bisulphide of Methyl. Sulphomethylo-sulphuric Acid.—By treatment of bisulphide of methyl with nitric acid, Muspratt obtained *sulphomethylo-sulphuric acid*; the lead-salt of this acid crystallizes in fine rhombic plates, $PbO, C_2 H_3 S_2 O_4 + HO$, from which aqueous vapour, together with a compound of a penetrating odour, is evolved on heating.(1)

Formation of Sulphocarbonate of Oxide of Methyl.—Zeise(2), and subsequently Cahours(3), produced sulphocarbonate of oxide of methyl, $C_2 H_3 O, CS_2$, by the action of iodine upon a solution of methylo-xanthonate of potassa ($KO, C_2 H_3 O, 2 CS_2$). Desains(4) is of opinion, that the first result of this reaction is the formation of iodide of potassium, and a compound, $C_4 H_3 S_4 O_2$, from which sulphocarbonate of methyl is only produced on distillation (compare below, the account of the corresponding ethyl-compound). The compound $C_4 H_3 S_4 O_2$, according to his statements, is obtained in the form of oily drops, by the action of a solution of iodine in wood-spirit, upon an aqueous solution of methylo-xanthonate of potassa; the quantity of carbon and hydrogen found in this substance, agrees with the above formula.

Action of Chlorine upon Oxalate of Oxide of Methyl.—Cahours(5) has found that chlorine, when acting under the direct influence of solar irradiation, rapidly converts oxalate of methyl ($C_4 H_3 O_4$) into the compound, $C_4 H Cl_2 O_4$, discovered by Malaguti; by continued action, this body is converted into a solid substance, crystallizing in white, brilliant, nacreous plates, and having the composition,

(1) Several chemists are of opinion, that sulphethylo-sulphuric acid, in the hypothetical anhydrous state, is $C_4 H_5 S_2 O_5$; in this case, sulphomethylo-sulphuric acid would be $C_2 H_3 S_2 O_5$, *i. e.*, identical with the preceding acid.

(2) Report of the Danish Academy, April, 1846, 55; Ann. Ch. Pharm. LXII, 375; J. Pr. Chem. XL, 292; Ann. Ch. Phys. [3] XX, 121; Berzelius' Jahresber. XXVII, 549.

(3) Compt. Rend. XXIII, 821; Ann. Ch. Phys. [3] XIX, 158; J. Pr. Chem. XL, 335; Berzelius' Jahresber. XXVII, 549.

(4) Ann. Ch. Phys. [3] XX, 496; J. Pr. Chem. XLII, 292; Compt. Rend. XXIII, 1089 (in abstr.); Ann. Ch. Pharm. LXIV, 325.

(5) Ann. Ch. Phys. [3] XIX, 342; J. Pr. Chem. XL, 425; Ann. Ch. Pharm. LXIV, 312, (in abstr.).

Action of chlorine upon oxalate of oxide of methyl.

$C_4 Cl_3 O_4$. When heated, it fuses and sublimes, with partial decomposition, and evolution of chlorocarbonic acid (CO Cl). The vapour of this compound, when passed through a glass tube, heated from 350° to 400°, splits entirely into chlorocarbonic acid, and carbonic oxide ($C_4 Cl_3 O_4 = 3\ CO\ Cl + CO$). Ether and acetone rapidly decompose this body, with evolution of chlorocarbonic acid, and formation of liquid or mucilaginous compounds, not yet accurately studied. Aqueous solutions of the fixed alkalies yield with it chlorides of the alkali-metals, together with alkaline carbonates and oxalates. Dry ammonia converts it into a mixture of chloride of ammonium and carbamide. Aniline and nicotine decompose it quickly; the products are not yet investigated. The various alcohols violently decompose the chlorinated product, with evolution of heat, and disengagement of chlorocarbonic acid; on addition of water, an oily compound separates, which is freed from hydrochloric acid by frequent washing, and dried by digestion with chloride of calcium.—If alcohol be employed, an oily liquid is obtained, which commences to boil at 92°, the boiling-point slowly rising to 190°. The first product of distillation, when several times rectified, yields a liquid boiling between 94° and 96°, of an odour which strongly irritates the eyes, and of the composition of formiate of oxide of ethyl, in which 1 H is replaced by Cl, namely, $C_6 H_5 Cl O_4$. That which distils from 187° to 188°, is oxalic ether, $C_6 H_5 O_4$. The action of alcohol upon $C_4 Cl_3 O_4$, accordingly, appears to be represented by the following equation:

$$C_4 Cl_3 O_4 + 2\ C_4 H_6 O_2 = 2\ HCl + C_6 H_5 O_4 + C_6 H_5 Cl O_4.$$

By employing wood-spirit, an oily product is formed, whose boiling-point rises from 80° to 162°; the limpid, suffocating liquid, distilling from 78° to 82°, has the composition of formiate of oxide of methyl, in which 1 H is replaced by 1 Cl, namely, $C_4 H_3 Cl O_4$; that which distils at 162° is oxalate of oxide of methyl, $C_4 H_3 O_4$.—The oily product of the reaction with fusel-oil consists of a liquid boiling at from 150° to 160° (probably a substitution-compound of formiate of oxide of amyl, $C_{12} H_{11} Cl O_4$), and oxalate of oxide of amyl, boiling at 260°(1).

(1) The boiling-points of the various formic ethers and their substitution-products exhibit a simple relation:

$C_4 H_4 O_4$	33°	45	$C_6 H_6 O_4$	55°	41	$C_{12} H_{12} O_4$	116°	44
$C_4 H_3 Cl O_4$	78		$C_6 H_5 Cl O_4$	96		$C_{12} H_{11} Cl O_4$	160	

The same difference of composition, however, is attended in other cases with another difference of the boiling-point.

Action of chlorine upon formiate of oxide of methyl.

Action of Chlorine upon Formiate of Oxide of Methyl.—According to Cahours, formiate of oxide of methyl, especially under solar irradiation, absorbs chlorine, rapidly at first, but more slowly after some time; from ten to fifteen days being necessary, in a strong light, to complete the reaction upon from 20 to 25 grm. of substance. The resulting liquid, which is rendered yellow by absorption of chlorine, becomes colourless on distillation; the greater portion distils between 176° and 190°, and by several rectifications a colourless liquid is obtained, boiling between 180° and 185°, of a spec. grav. 1·724 at 12°, and of a strong irritating odour. This liquid is, $C_4 Cl_4 O_4$, formiate of oxide of methyl, in which the whole of the hydrogen is replaced by chlorine, polymeric with chlorocarbonic acid (C O Cl). When exposed to a temperature from 320° to 350°, $C_4 H_4 Cl_4$ is converted into this gas. With alcohol, or wood-spirit, it becomes heated; addition of water to the mixture separates the above-mentioned compounds, $C_6 H_5 Cl O_4$, or $C_4 H_3 Cl O_4$. Aqueous potassa-solution, even when concentrated, does not decompose it; aqueous ammonia, however, decomposes it immediately, even in the cold, with evolution of heat, formation of chloride of ammonium, and separation of white scales, of the lustre of mother-of-pearl; the latter are insoluble in water, but soluble in ether, and consist of chloracetamide, $C_4 H_2 Cl_3 NO_2$.

Salicylate of Oxide of Methyl. Action of Sulphuro-nitric Acid.—According to Cahours(1), when salicylate of oxide of methyl ($C_{16} H_8 O_6$) is added, drop by drop, to a mixture of equal parts of fuming nitric- and sulphuric acid, heating being prevented by means of cold water, a transparent, deep orange-yellow liquid is obtained. If a farther quantity of the acid mixture be added as soon as the last drops of salicylate of oxide of methyl cease to dissolve, and the whole be agited until complete solution is effected, the mixture, when diluted after some minutes with from 7 to 8 times its volume of water, deposits a solid, bright-yellow body, which is obtained in a state of purity by recrystallization from alcohol (the alcoholic mother-liquor retaining in solution a substance which will be mentioned below). Thus purified, it forms pale-yellow scales; it is heavier than water, and fuses at from 124° to 125° to a bright-yellow liquid, which becomes a fibrous solid on cooling. Its composition is $C_{16} H_6 (NO_4)_2 O_6$, salicylate of oxide of methyl, in which 2 H are replaced by 2 NO_4; in

(1) Loc. cit. I. 295; Compt. Rend. XXVII, 485 (in abstr.); Instit. 1848, 351.

Salicylate of oxide of methyl. Action of sulphuro-nitric acid.

consequence of salicylate of oxide of methyl exhibiting the comportment of an acid (termed gaultheric acid, from the occurrence of the oil in *Gaultheria procumbens*) Cahours designates it *binitrogaultheric acid* (*acide gaulthérique binitrique*). When dissolved in an excess of a hot solution of ammonia, this acid forms a salt, which, on slowly cooling, crystallizes in yellow needles, $NH_4 O$, $C_{16} H_5 (NO_4)_2 O_5$, slightly soluble in cold, but very soluble in hot water; a dilute solution, when treated with nitrate of protoxide of silver, yields a chrome-yellow silver-salt, of a corresponding composition.—Binitrogaultheric acid, when cautiously heated in a small, closed glass tube, sublimes, undecomposed, in small brilliant plates; rapidly heated, it is decomposed; heated from 30^0 to 40^0 in concentrated sulphuric acid, it is dissolved without decomposition, and again separated by water; by heating to from 75^0 to 80^0, a violent reaction ensues, carbonic acid being evolved, and the liquid assuming a red colour; if the temperature be maintained within these limits (by immersion in water), carbonic acid only is disengaged; addition of water then renders the liquid cloudy, and on cooling small yellow needles are separated, slightly soluble in hot alcohol and water, and crystallizing again on cooling. If the temperature rises above 100^0, sulphurous acid is likewise evolved, the liquid blackens, and water then separates from it only brown, amorphous flakes.—Ordinary, or fuming nitric acid, at from 30^0 to 40^0, dissolves binitrogaultheric acid without decomposition; addition of water separates it again; by boiling, however, it is entirely converted into picric acid.—Binitrogaultheric acid is dissolved by aqueous solutions of the alkalies in the cold, without decomposition, crystalline salts being formed; by ebullition, however, with dilute potassa-solution the acid is destroyed, a splendid red salt being obtained, becoming yellow by treatment with dilute nitric acid. It is only slightly soluble in water, but dissolves perfectly on addition of a sufficiency of the solvent; on cooling, this liquid deposits a crystalline chrome-yellow salt, which may be washed with cold water. The red salt is $2\,KO$, $C_{14} H_3 (NO_4)_2 O_5$, it detonates upon ignited coals, and appears to be perfectly decomposed by continuous ebullition with concentrated potassa-solution; the yellow salt is KO, $C_{14} H_3 (NO_4)_2 O_5$. Concentrated sulphuric acid separates from both salts *binitrosalicylic acid*, $C_{14} H_4 (NO_4)_2 O_6$, which is slightly soluble in cold and readily soluble in hot water; this acid, which may be considered as salicylic acid, in which $2\,H$ are replaced by $2\,(NO_4)$, crystallizes in satiny needles, or small, hard prisms; it is readily soluble in alcohol and

Salicylate of oxide of methyl. Action of sulphuro-nitric acid.

ether, fusible at a slight elevation of temperature, and subliming, when cautiously heated, without decomposition; it gives a cherry-red colour with salts of sesquioxide of iron, and dissolves in sulphuric acid at a low temperature without decomposition (being separated again by water), while at a higher temperature, it is decomposed; by boiling with concentrated nitric acid, it is converted into picric acid. It yields an ammonia-salt, $NH_4 O, C_{14} H_3 (NO_4)_2 O_5$, crystallizing in small yellow needles; when diluted and heated, it dissolves carbonate of protoxide of silver, and deposits, on cooling, an anhydrous silver-salt in crystalline grains; it yields with baryta-water an orange-yellow precipitate, and with soda a salt, crystallizing in satiny needles. If it be dissolved in spirits of wine through which a current of dry hydrochloric acid is passed at the boiling temperature, and the liquid be evaporated to one half by gently boiling, addition of water separates the compound $C_4 H_5 O, C_{14} H_3 (NO_4)_2 O_5 = C_{18} H_8 (NO_4)_2 O_6$ as a heavy oil, which soon solidifies. When washed with water and recrystallized from boiling alcohol, this substance is obtained in the form of small tables, resembling binitrogaultheric acid; like the latter body, it forms crystallizable salts with the alkalies; it fuses at a slight increase of temperature and solidifies with a fibrous texture; after lengthened fusion it remains liquid for a considerable time and then solidifies as a resin; with concentrated potassa-solution it again yields binitrosalicylate of potassa.

In the alcoholic mother-liquor from which binitrogaultheric acid has been deposited (II. 7), a substance remains dissolved, which crystallizes on evaporation; it may be obtained in a purer state by treatment with a small quantity of cold alcohol (in which it readily dissolves, a residue of binitrogaultheric acid being left), and spontaneous evaporation. It forms pure, transparent, yellow tables, containing $C_{16} H_5 (NO_4)_3 O_6$ (salicylate of oxide of methyl, or gaultheric acid, in which 3 H are replaced by 3 (NO_4),); it is, however, always mixed with picric acid.—The mixture of fuming nitric- and sulphuric acids acts in a totally different manner upon anisic acid, which is isomeric with salicylate of oxide of methyl (comp. I. 412).

Cyanurate of Oxide of Methyl has been obtained by Wurtz(1) by distilling cyanurate or cyanate of potassa with sulphomethylate

(1) Compt. Rend. XXVI, 368.

Cyanate of oxide of methyl.

of potassa. Repeatedly crystallized from alcohol it forms small colourless crystals, fusing towards 140° and volatilizing at 295°; its vapour-density was found to be 5·98; the formula $3\,C_2\,H_3\,O,\,C_6\,N_3\,O_3$, corresponding to a condensation to 4 vols., requires a vapour-density of 5·94.

Cyanate of Oxide of Methyl.—According to Wurtz(1) cyanate of methyl, $C_2\,H_3\,O,\,C_2\,N\,O$, is obtained as a very volatile liquid, by distilling cyanate of potassa with an alkaline sulphomethylate, and separation of the volatile portion of the distillate from the simultaneously formed cyanurate; it forms with ammonia a crystalline substance $C_4\,H_6\,N_2\,O_2$; with water it yields, with evolution of carbonic acid, a crystalline body $C_6\,H_8\,N_2\,O_2$, isomeric with the product of the action of aqueous ammonia upon cyanate of oxide of ethyl. With regard to its products of decomposition, cyanate of oxide of methyl comports itself analogously to the latter body, which is described farther on.

Chloroform.—Numerous communications have been published upon the preparation of chloroform, which, according to Huttmann(2), has been known from an early period, being described in Porta's *Magia naturalis* [1567] and Scott's Letters upon Demonology, as a means of inducing stupefaction. Its preparation from spirit of wine, by means of chloride of lime, has been described by Soubeiran(3), Meurer(4), Laroque and Huraut(5), Godefrin(6), and Carl(7), its preparation on a large scale by L. Kessler(8); that from a mixture of chloride of ethyl and spirit of wine by means of chloride of lime, by Pierloz-Feldmann(9); that from acetate of soda and chloride of lime, by R. Böttger(10), and that from acetate

(1) Compt. Rend. XXVII, 241; Laurent and Gerhardt's Compt. Rend. des Trav. Chim. 1849, 117; J. Pr. Chem. XLV, 316.

(2) J. Chim. Méd. [3] IV, 476.

(3) Compt. Rend. XXV, 799; J. Pharm. [3] XII, 427; J. Chim. Méd. [3] IV, 5; Arch. Pharm. [2] LIII, 274.

(4) Arch. Pharm. [2] LIII, 282.

(5) J. Pharm. [3] XIII, 97; J. Chim. Méd. [3] IV, 150; Compt. Rend. XXVI, 103; Instit. 1848, 38; J. Pr. Chem. XLIII, 396.

(6) J. Pharm. [3] XIII, 101.

(7) Pharm. Centr. 1848, 236.

(8) J. Pharm. [3] XIII, 161.

(9) J. Chim. Méd. [3] IV, 309; Instit. 1848, 196; Arch. Pharm. [2] LVI, 185; J. Pr. Chem. XLIV, 244.

(10) Polytechn. Notizblatt, 1848, No. 1.

of soda by means of hypochlorite of soda, by Reich(1). Wackenroder(2) has communicated some comparative experiments respecting the preparation from spirits of wine and acetate of soda by means of chloride of lime. Siemerling(3) has examined, in a similar manner, its preparation by means of chloride of lime, from wood-spirit. In all the modes of preparing chloroform, an excess of lime with the chloride of lime is indispensable, hence the advantage of adding milk of lime; the deposit is a crystalline compound of chloride of calcium with carbonate of lime, which is decomposed by washing with water.

Soubeiran(4) tests the purity of chloroform, by ascertaining whether it will sink in a mixture of equal parts of concentrated sulphuric acid and water; L. Kessler(5) has called attention to its adulteration with ether, and remarks, that chloroform, when agitated with Soubeiran's test-liquid, does not diminish in volume, while that which contains alcohol decreases; according to Mialhe(6) pure chloroform remains transparent when poured into water, while that which contains alcohol becomes opalescent; according to Cattel(7), that which contains alcohol is coloured green by chromic acid, or by bichromate of potassa and sulphuric acid, while pure chloroform is not affected by this treatment.

Swan(8) found the spec. grav. of chloroform to be from 1·493 to 1·497; Morson(9) states, that, under the influence of light and air it is decomposed with evolution of chlorine, hydrochloric acid, and formation of other products; but that it is not altered when preserved under water.

Iodoform. Its Products of Decomposition. — According to the statement of St. Evre's(10), if cyanogen be passed into an alcoholic solution of iodoform until absorption ceases, the liquid, which has become warm, and of a violet colour,—deposits, when allowed

(1) Gewerbvereinsblatt der Prov. Preussen, 1848, No. 2; Arch. Pharm. [2] LV, 65.
(2) Arch Pharm. [2] LIII, 273.
(3) Ibid. LIV, 23.
(4) Loc. cit. II. 10. sub. (3).
(5) J. Chim. Méd. [3] IV, 398; also loc. cit. II. 10. sub. (8).
(6) J. Chim. Méd. [3] IV, 279.
(7) J. Chim. Méd. [3] IV, 257, 401; J. Pharm. [3] XIII, 359; J. Pr. Chem. XLIV, 246; Arch. Pharm. [2] LVI, 322.
(8) Phil. Mag. [3] XXXIII, 38.
(9) Pharm. J. Trans. VIII, 69.
(10) Compt. Rend. XXVII, 533.

Ethyl-Compounds and their Correlatives. Alcohol.

to remain tranquil, groups of prismatic, golden-yellow, vine-leaf-shaped crystals. By treatment with cold dilute spirit of wine, two distinct substances of metallic lustre may be separated from this crystalline mass, a violet-coloured body $C_4 H I_2 N = C_2 H I_2 Cy$, and a greenish golden-yellow compound containing still less iodine.

Respecting bromoform comp. I. 385.

Ethyl-Compounds and their Correlatives. Alcohol.—Wackenroder(1) has communicated his experience respecting the preparation of absolute alcohol by means of caustic lime; he found its spec. grav. at 21° to be 0·7905 to 0·7897.—Mohr(2) has tested various methods of preparing *spiritus vini alcoholisatus*.

Mixtures of Alcohol and Water.—Drinkwater(3) has examined the spec. grav. of pure alcohol, and such aqueous mixtures as contain from 0·5 to 10 per cent by weight of alcohol; all determinations of the spec. grav. hold good for 15°·5 (doubtlessly referring to water of the same temperature as unit). By the repeated digestion of alcohol with freshly ignited and quickly powdered caustic lime, the spec. grav. was reduced to 0·79381, which may be considered as that of absolute alcohol. In the following table, B shows the spec. grav. of the aqueous mixtures, A representing the percentage-weights of alcohol which they respectively contain:

A	0·5	1	2	3	4	5
B	0·99905	0·99813	0·99629	0·99454	0·99283	0·99121
A	6	7	8	9	10	
B	0·98963	0·98813	0·98668	0·98527	0·98389	

The spirit of wine, to which the duty on spirituous liquors is referred in England (proof-spirit), and which, according to Act of Parliament, should have a spec. grav. $\frac{12}{13}$ that of water at 51° F., Drinkwater found to contain 49·24 per cent, by weight, of alcohol.

Fownes(4) has examined the spec. grav. of mixtures of water and alcohol with the following results (the column A represents the percentage-weight of alcohol in the mixture; the spec. grav. B refers to a temperature of 15·6):

(1) Arch. Pharm. [2] L, 162.

(2) Ibid. LIV, 295;

(3) Phil. Mag. [3] XXXII, 123; Chem. Soc. Mem. III, 447; Pharm. J. Trans. VII, 488.

(4) Pharm. J. Trans. VII, 375.

A.	B.	A.	B.	A.	B.	A.	B.
5	0·9914	30	0·9578	55	0·9069	80	0·8483
10	0·9841	35	0·9490	60	0·8956	85	0·8357
15	0·9778	40	0·9396	65	0·8840	90	0·8228
20	0·9716	45	0·9292	70	0·8721	95	0·8089
25	0·9652	50	0·9184	75	0·8603	100	0·7938

Determination of the proportion of alcohol in mixtures.

Determination of the proportion of Alcohol in Mixtures.—Despretz(1), in conjunction with Pouillet and Babinet, has reported to the Paris Academy, upon two instruments for determining the proportions of alcohol in spirituous liquors, containing substances in solution, which increase the spec. grav. of the mixture. The construction of both instruments is based upon the fact, that the more alcohol the liquids contain the lower will be their boiling-points; they are both designated by the term *ebullioscope*. Brossard-Vidal's instrument(2) is a thermometer of large dimensions, which is immersed in the liquid to be examined; the mercury contained in the tube carries a float which is furnished with a cord passing over a roller, and supported by a light counterpoise; in the roller is a needle, which, according to the variations of the level of the mercury in the tube, points to a different mark on an empirically graduated scale, (as with Hooke's wheel-barometer). Conaty's ebullioscope is an ordinary thermometer, whose scale directly indicates the proportion of alcohol contained in a mixture into which it is immersed during ebullition; the scale, moreover, is moveable, which allows an adjustment for variations in the height of the barometer, so as to dispense with farther corrections. Both instruments are said to be capable of accurately indicating 1 or 2 per cent of alcohol in a liquid; the instrument of Conaty is stated to be the most convenient.

Ure(3) did not find the use of Brossard-Vidal's instrument advantageous; he, therefore, constructed one himself, on a principle similar to that of Conaty. With regard to the details of its use, we refer to his communication, and only give the following observations of the boiling-points A (at 29·5 engl. inch Bar.?) of mixtures of alcohol and water, having a spec. grav. B (at $15^{0}{\cdot}5$?).

A	$81^{0}{\cdot}4$	$82^{0}{\cdot}1$	$82^{0}{\cdot}5$	$83^{0}{\cdot}3$	$84^{0}{\cdot}1$	$85^{0}{\cdot}3$	$87^{0}{\cdot}2$	$88^{0}{\cdot}8$	$91^{0}{\cdot}3$	$94^{0}.4$
B	0·9200	0·9321	0·9420	0·9516	0·9600	0·9665	0·9729	0·9786	0·9850	0·9920

(1) Compt. Rend. XXVII.
(2) A more detailed description, with a cut, is given in Pharm. J. Trans. VII, 166.
(3) Pharm. J. Trans. VII, 166.

Alcoholates.

Silbermann(1) has proposed to ascertain the proportion of alcohol in dilute spirits, by determining the expansion by heat, and has described an instrument constructed for this purpose.

Alcoholates.—Einbrodt(2) has expressed some doubts as to whether the bodies described under the term alcoholates (compounds of alcohol with anhydrous salts) are not, properly speaking, mixtures of the crystals of hydrated salts with their alcoholic solutions.

Seleno-Mercaptan.—Hydroseleniate of selenide of ethyl has been prepared by C. Siemens(3). Hydroseleniate of selenide of potassium (KSe+HSe, prepared by saturating potassa with hydroselenic acid, hydrogen being simultaneously passed through the solution, in order to exclude the air) was rapidly mixed and distilled with a concentrated solution of sulphethylate of lime; free hydroselenic acid was at first evolved, and subsequently a fetid liquid distilled over, which sank to the bottom of the water; when dried with chloride of calcium and submitted to fractional distillation, it yielded seleno-mercaptan ($C_4 H_5 Se$, HSe) as the most volatile portion. This substance is colourless, of a fetid odour, resembling that of cacodyl-compounds, heavier than water, in which it is insoluble, boiling far below 100°, readily inflammable, and burning with an intensely bright blue flame, vapours of selenious acid and selenium being evolved. It combines with protoxide of mercury, with hissing and evolution of heat, forming a yellow, readily fusible body, soluble in hot alcohol, from which it separates, on cooling, in the amorphous state; an alcoholic solution of seleno-mercaptan yields a copious yellow precipitate with protochloride of mercury.—The least volatile portion of the liquid obtained in the above process is either a mixture of seleno-mercaptan with biselenide of ethyl, or of selenide and biselenide of ethyl; it is yellow, heavier than water, very fetid, and has no action upon protoxide of mercury.

Ether. Crystalline form of its Substitution-Products.—Nicklès(4) has examined the crystalline form of two substitution-products of ether, namely of the compounds $C_4 Cl_5 O$ and $C_4 Cl_3 Br_2 O$. Both compounds are isomorphous, and belong to the square-prismatic system; they exhibit a square pyramid P, whose ends are frequently truncated by 0 P. The length of the principal axis for P is calculated for both substances at 0·952, from the measurements given by

(1) Compt. Rend. XXVII, 418; Chem. Gaz. 1849, 25.
(2) Ann. Ch. Pharm. LXV, 115; Chem. Gaz. 1848, 85; J. Pr. Chem. XLVI, 165.
(3) Ibid. LXI, 360; J. Pr. Chem. XL, 503, (in abstr.).
(4) Ann. Ch. Phys. [3] XXII, 28.

Nicklès, (the inclination of the planes in the lateral edges = 106°·46′); the pyramid, therefore, is very similar to a regular octohedron, which form, at an earlier period, had been erroneously assigned to them. The cleavage of both substances is parallel to 0 P.

Liquid isomeric with chloride of ethyl.

Liquid isomeric with Chloride of Ethyl.—A liquid, isomeric with chloride of ethyl, in which 4 H are replaced by 4 Cl, has been obtained by Pierre(1), by exposing to the action of chlorine oil of olefiant gas (liquid of the Dutch chemists, chloride of elayl, $C_4 H_4 Cl_2$). Chlorine was rapidly passed, during ten or twelve hours, into 400—500 grms of that liquid, covered with a layer of water and exposed to solar radiation, the whole being kept constantly cool; the lower stratum was subsequently distilled, and that which passed over from 145° to 160° repeatedly rectified, the first and last portion of the distillate being separated until the boiling-point became constant. A liquid was thus obtained, of a spec. grav. 1·66267 at 0°, possessing an agreeable, somewhat melliferous odour, and a sweet and hot taste. It remains liquid at 0°, boils at 153°·8 under a barometric pressure of 763^{mm}·4, and has the composition $C_4 H Cl_5$; the density of its vapour was found = 7·087, the calculated number for a condensation to 4 vols. is 7·101. This compound yields, when treated with alcoholic solution of potassa, the chloride of carbon $C_4 Cl_4$, chloride of potassium and water.

Crystalline Form of $C_4 Br_2 Cl_4$ and $C_4 Cl_6$.—Nicklès(2) has examined the crystalline form of bromochloride of carbon ($C_4 Br_2 Cl_4$), and found it concordant with that of the chloride of carbon, $C_4 Cl_6$. Respecting the latter, it has been ascertained by Brooke's(3) and Laurent's(4) measurements, that it affects the form of a right rhombic prism ∞ P, (whose angles are 58° and 122° according to Brooke, and 59° and 121° according to Laurent), exhibiting ∞ P̆ ∞ and the brachydiagonal doma P̆ ∞ (whose planes, above and below, are inclined at an angle of 59° 20′ according to Brooke, at 59° 0′ according to Laurent), and presenting the following axial ratios:

		according to:
Brachydiagonal : Macrodiagonal : Principal axis	= 0·554 : 1 : 1·804	Brooke,
	= 0·566 : 1 : 1·768	Laurent.

(1) Ann. Ch. Phys. [3] XXI, 439; J. Pr. Chem. XLIII, 301; Compt. Rend. XXV, 430, (in abstr.).

(2) Ibid. [3] XXII, 30.

(3) Annals of Philosophy XXIII, 364.

(4) Quesneville's Revue Scientifique, IX, 33.

Iodide of ethyl.

Iodide of Ethyl.—According to Pierre(1), chlorine forms with iodide of ethyl, chloride of ethyl ($C_4 H_5 Cl$), with liberation of iodine.

Sulphide of Ethyl.—By rapidly passing chlorine into sulphide of ethyl ($C_4 H_5 S$), even in a feebly lighted place, and with exclusion of air, the liquid, according to Pierre(2), becomes heated and frequently takes fire (hence the necessity of avoiding too large a quantity); chloride of ethyl, $C_4 H_5 Cl$, is formed, with deposition of sulphur. The formation of chloride of sulphur is, in this case, not easily avoided, and if the operation be conducted too rapidly $C_4 H_4 Cl_2$ is likewise produced.

Cyanide of Ethyl.—Respecting cyanide of ethyl and its decomposition by hydrate of potassa, comp. I. 424.

Decomposition of Cyanide of Ethyl by Potassium.—Frankland and Kolbe(3) have investigated the decomposition of cyanide of ethyl by potassium. If the cyanide be allowed to act, drop by drop, upon potassium, a violent reaction ensues, flashes of fire even appear, with evolution of a gaseous body, while the potassium is finally converted into a viscid, yellow mass, which, when treated with water, yields a solution of cyanide of potassium, cyanethine (comp. I. 500) remaining behind. The gas has the composition $C_2 H_3$; its spec. grav. was found to be 1·075; the calculated number, 1·037, agrees with a condensation to 2 vols. It is colourless, not condensible at — 18°, of a feebly ethereal odour, and is insoluble in water; alcohol absorbs 1·13 times its volume. It is not acted upon by concentrated sulphuric acid, nor by sulphur or iodine, even when heated with these bodies. Chlorine mixes with it in the dark without action; in diffused light, however, the colour of the chlorine disappears, and there is formed, without diminution of volume, a mixture of equal measures of hydrochloric acid gas and a gaseous body, of the composition of chloride of ethyl ($C_4 H_5 Cl$), with whose vapour-density it likewise agrees; this gas, however, is not identical but only isomeric with chloride of ethyl, since the former remains gaseous at — 18°, and is absorbed by double its volume of water.

Action of Nitric Acid upon Sulphocyanide of Ethyl. Hyposulphethylic Acid.—Cahours had stated that sulphocyanide of ethyl ($C_6 H_5 S_2 N$) is dissolved when heated with moderately concentrated nitric acid, and separates again on cooling. J. S. Muspratt(4)

(1) From the Recueil, &c. (comp. II. 3), in J. Pharm. [3] XIII, 157.
(2) Ibid.
(3) Chem. Soc. Qu. J. I, 60; Ann. Ch. Pharm. LXV, 269.
(4) Chem. Soc. Qu. J. I, 45; Ann. Ch. Pharm. LXV, 251; J. Pharm. [3] XIII, 302.

finds that sulphocyanide of ethyl (obtained by distilling in a capacious retort equal volumes of saturated solutions of sulphethylate of lime and sulphocyanide of potassium), is very quickly altered by moderately concentrated nitric acid; by gently warming equal weights of both substances in a retort, a violent reaction commences, with evolution of nitrous acid, binoxide of nitrogen, and carbonic acid; sulphuric acid is more or less formed, according to the concentration of the acid employed. The distillate is frequently returned, and the contents of the retort finally evaporated in a water-bath until the nitric acid is completely expelled, when a liquid remains, resembling oil of vitriol, and possessing a feeble garlic-like odour; it is *hyposulphethylic acid*. This compound is obtained in a state of purity by decomposing the baryta-salt with sulphuric acid, saturating the filtrate with carbonate of protoxide of lead, filtering again, and decomposing the lead-salt with hydrosulphuric acid; the acid, when filtered from the sulphide of lead and evaporated in a water-bath, is perfectly pure. After having been fused with hydrate of potassa, addition of sulphuric or hydrochloric acid copiously evolves sulphurous acid; it withstands a high temperature without decomposition, has an acid and disagreeable taste, is miscible with water and alcohol in all proportions, and forms only soluble salts.—The baryta-salt is so soluble, that it can only be obtained in fine rhombic prisms, $BaO, C_4 H_5 S_2 O_5 + HO$, by slowly evaporating a concentrated solution; it loses its water at 100°. This salt is likewise readily soluble in dilute spirit of wine and in ether, but insoluble in absolute alcohol, which precipitates it from its aqueous solution. By strongly heating it, white vapours of suffocating odour are evolved, a pyrophoric residue remaining behind.—The lead-salt crystallizes from the hot concentrated solution in colourless tables, $PbO, C_4 H_5 S_2 O_5 + HO$, which are readily soluble in water and alcohol; they lose their water of crystallization at 100°; when strongly heated, they intumesce and leave a black residue, which contains sulphate of lead.—The copper-salt, on account of its great solubility, is obtained only with difficulty in distinct crystals, of the composition $CuO, C_4 H_5 S_2 O_5 + HO$.

Action of nitric acid upon sulphocyanide of ethyl. Hyposulphethylic acid

According to Muspratt, hyposulphethylic acid is likewise formed by treating sulphocyanide of ethyl with chlorate of potassa and hydrochloric acid. This compound is only slowly decomposed by chlorine; after continued action, chloride of cyanogen is abundantly produced, and subsequently a heavy yellow oil, which is insoluble in water. When left in contact for several days with cold alcoholic solution of potassa, sulphocyanide of ethyl is decomposed, the liquid becomes of a blood-red colour and acquires a peculiar odour.

Action of nitric acid upon bisulphide of ethyl.

Action of Nitric Acid upon Bisulphide of Ethyl.—According to Muspratt, bisulphide of ethyl ($C_4 H_5 S_2$) yields with nitric acid the sulphethylo-sulphuric acid discovered by Löwig and Weidmann. For the copper-salt of this acid, dried at 100°, he found the composition $CuO, C_4 H_5 S_2 O_4 + 4 HO$.

Decomposition of the Substitution-Products of Compound Ethers.—Gerhardt(1) has given a synopsis of the decompositions exhibited by the chlorinated compound ethers under the influence of heat, of potassa, and of ammonia. He illustrates these reactions by the formulæ which he adopts for these compounds.

Action of Hydrosulphuric Acid upon Nitrite of Oxide of Ethyl.—According to E. Kopp(2), hydrosulphuric acid acts rapidly and violently upon nitrite of oxide of ethyl; sulphur is deposited, and from the supernatant fluid an ammoniacal liquid may be distilled, which, when saturated with hydrochloric acid, yields on distillation, an alcoholic solution, of a feeble garlic-like odour; $C_4 H_5 O, NO_3 + 6HS = C_4 H_6 O_2 + 2 HO + NH_3 + 6 S$. Hunt(3) has arrived at the same result.

Action of Hydrosulphuric Acid upon Nitrate of Oxide of Ethyl.—E. Kopp has farther found, that the action of hydrosulphuric acid is less violent upon nitrate of oxide of ethyl. When a current of this gas is passed into nitric ether, which is mixed with an alcoholic solution of ammonia, the temperature rises to 35° or 40°, the liquid becoming of a darker colour, with separation of sulphur. On distillation, only traces of nitrate of ammonia are found in the residue; the distillate contains ammonia and mercaptan, the latter is likewise produced when no alcohol is employed. $C_4 H_5 O, NO_5 + 10 HS = C_4 H_6 S_2 + NH_3 + 6 HO + 8 S$.

Formation of Sulphocarbonate of Oxide of Ethyl.—According to Desains(4) the formation of sulphocarbonate of oxide of ethyl ($C_4 H_5 O, C S_2$), by the action of iodine upon an alcoholic solution of xanthonate of potassa ($KO, C_4 H_5 O, 2 CS_2$) and distillation, is effected simply by the separation of 1 eq. of potassium by 1 eq. of iodine, which gives rise to the production of a compound, $C_6 H_5 S_4 O_2$. This compound, according to his statements, is obtained pure if an alcoholic solution of xanthonate of potassa, mixed with a quantity of iodine sufficient to decolourize it, is allowed to evaporate spontaneously; after some days, the body separates on reducing the temperature, in

(1) J. Pharm. [3] XIV, 229.

(2) Quesneville's Revue Scientifique, XXVII, 273; J. Pharm. [3] XI, 320; Ann. Ch. Pharm. LXIV, 320.

(3) Sill. Am. J. [2] IV, 350.

(4) Loc. cit. II, 5.

Formation of sulphocarbonate of oxide of ethyl.

the form of leafy crystals, which require only to be washed with water. It readily fuses, by the temperature of the hand, to a yellowish oil. The same compound is obtained, at a low temperature, as a whitish powder, on addition of tincture of iodine to an aqueous solution of xanthonate of potassa. Hydrochloric acid does not change it even at the boiling temperature; sulphuric acid decomposes it with evolution of sulphurous acid. With an alcoholic solution of this compound, potassa produces a deposit of xanthonate of potassa; it colours an alcoholic solution of ammonia brown, with separation of sulphur, the liquid yielding crystalline crusts, which appear to be a mixture of several bodies. This compound, when distilled in an oil-bath at from 200° to 210°, yields sulphocarbonate of oxide of ethyl, a hard mass remaining in the retort, from which sulphur is extracted by bisulphide of carbon; it evolves, moreover, carbonic acid and the vapour of bisulphide of carbon [Desains gives the formula $2\,(C_6\,H_5\,S_4\,O_2) = 2\,(C_4\,H_5\,O, CS_2) + CS_2 + CO_2 + S_2$].

Cyanurate of Oxide of Ethyl.—According to Wurtz(1), cyanurate of oxide of ethyl is obtained by the distillation of alkaline cyanurate of potassa with sulphethylate of lime. It is condensed in the neck of the retort and in the receiver as a crystalline mass, which, by recrystallization from alcohol, is obtained in splendid, perfectly pure crystals. Cyanuric ether fuses at 85° to a colourless liquid, of greater spec. grav. than water; at 276° it boils and volatilizes without decomposition; the density of its vapour was found = 7·4; 7·37 is the calculated number, assuming that $3\,C_4\,H_5\,O, C_6\,N_3\,O_3$ give 4 vols. of vapour. It is slightly soluble in water, and readily soluble in alcohol and ether.

Cyanate of Oxide of Ethyl.—By the distillation of dry cyanate of potassa with sulphethylate of potassa, a mixture of cyanurate and cyanate of oxide of ethyl is obtained; the latter (boiling about 60°) is easily isolated by its greater volatility. Cyanate of oxide of ethyl(2), when rectified several times over chloride of calcium, is a mobile liquid, which strongly refracts the light; it is lighter than water, its vapour excites a flow of tears. The density of its vapour was found = 2·4, agreeing with a condensation of $C_4\,H_5\,O, C_2\,N\,O$ to 4 vols. in the state of vapour.—Cyanate of oxide of ethyl dissolves in aqueous ammonia with elevation of temperature; on evaporation, a compound $C_6\,H_8\,N_2\,O_2$, is obtained, crystallizing in splendid prisms, fusible, and

(1) Compt. Rend. XXVI, 368.

(2) Ibid. XXVII, 241; Laurent and Gerhardt's Compt. Rend. des Trav. Chim. 1849, 117; J. Pr. Chem. XLV, 316.

Cyanate of oxide of ethyl.

soluble in water and alcohol; it contains the elements of cyanate of oxide of ethyl and ammonia, and is isomeric with the product (cited II, 10) of the decomposition of cyanate of oxide of methyl by water. Cyanate of ethyl, when brought in contact with water, evolves carbonic acid, and is converted into a crystalline body, $C_{10}\ H_{12}\ N_2\ O_2$, which is purified by solution in water or alcohol.

Sulphate of Oxide of Ethyl.—Neutral sulphate of oxide of ethyl $C_4\ H_5\ O,\ SO_3$, has been obtained by Wetherill(1) on passing the vapour of anhydrous sulphuric acid into ether surrounded by a frigorific mixture; the thick syrupy liquid thus formed, was agitated with an equal volume of ether and four times its bulk of water; the upper stratum, containing the sulphate of oxide of ethyl dissolved in ether, was then separated, agitated with milk of lime, washed with water, filtered and separated from the ether by evaporation; finally, the remaining acid oily liquid was repeatedly washed with water and dried *in vacuo*. This compound is thus obtained as an oily liquid, of an acrid taste, of the odour of oil of peppermint; in the pure state it is colourless, but generally it is yellow; its spec. grav. is 1·120, and can only be distilled without decomposition with the aid of the greatest care and in a stream of carbonic acid; it causes upon paper a greasy stain, which disappears again after some days. It gives with hydrosulphate of sulphide of potassium, mercaptan and sulphate of potassa; it dissolves in fuming nitric acid and is again separated by water; the solution, neutralized with potassa and heated, yields nitrous ether ($C_4\ H_5\ O,\ NO_3$). Sulphate of oxide of ethyl, when heated with water, forms an acid liquid, without separation of oil of wine; by boiling, the acid solution yields alcohol; when treated with carbonate of baryta, it forms three distinct soluble baryta-salts: methionate, sulphethylate, and isethionate of baryta. The former, when dried at 100°, is $BaO,\ CH_3\ S_2\ O_7$; it crystallizes out first, and may be precipitated from the aqueous solution by spirit of wine.

Millon(2) has observed, that alcohol and sulphuric acid ($HO,\ SO_3$) when mixed together at 0°, an increase of temperature being carefully avoided, do not give rise to sulphethylic acid, even in the course of several days; this transformation, however, takes place slowly at from 10° to 15°, and after some days 77 per cent of the quantity which can be produced from the amount of sulphuric acid employed, is converted into sulphethylic acid. At from 30° to 35°, the transformation takes

(1) Ann. Ch. Pharm. LXVI, 117; J. Pharm. [3] XIV, 225.

(2) Ann. Ch. Phys. [3] XIX, 227; J. Pr. Chem. XL, 366; Phil. Mag. [3] XXX, 211.

Sulphate of oxide of ethyl.

place in a few hours, by warming the mixture in a water-bath in some minutes, and instantaneously when the acid is added to the alcohol so as to occasion a considerable elevation of temperature; sulphethylic acid, however, is always formed in the above proportion. 2 eq. of alcohol and 1 eq. of sulphuric acid, comport themselves in a similar manner; they give rise, however, to somewhat less sulphethylic acid, (from 73 to 74 per cent of the possible quantity). By mixing 2 eq. of sulphuric acid with 1 eq. of alcohol under all circumstances, the same amount (54 per cent of the possible quantity) of sulphate of oxide of ethyl is formed.

Sulphethylates.—R. F. Marchand(1) has investigated the change suffered by sulphethylates which had been prepared twelve years previously. The salts of potassa, soda, lithia, ammonia, magnesia, protoxide of copper, protoxide of nickel, protoxide of cobalt and protoxide of zinc, had remained undecomposed. The strontia-salt had been almost entirely converted into sulphate, with formation of an acid liquid, possessing an agreeable vinous odour; the baryta-salt had been likewise changed. The lime-salt was not completely decomposed. The salt of alumina, of sesquioxide of iron, of protoxide of manganese, of sesquioxide of uranium, of protoxide of lead, and of protoxide of silver, were entirely decomposed. No oil of wine could be obtained from the resulting acid liquid. Marchand, as also Gerhardt(2), has observed, that by boiling a solution of the baryta-salt, neutralizing the acid liquid produced with baryta, re-boiling, &c., a liquid is finally obtained, which is no longer decomposed by ebullition, and gives crystals of the same composition as those of sulphate of oxide of ethyl and baryta, but of different properties.

Phosphethylic Acid and Phosphobiethylic Acid.—Zeise has observed, that when phosphorus is left in contact with ether for some time, if the liquid poured off be distilled to $\frac{1}{20}$th and the remaining acid liquid be diluted and saturated with baryta-water, three distinct baryta-salts are obtained, one insoluble, another difficultly soluble, and a third readily soluble; the acid of the latter he designates as phosphethylic acid.—Voegeli(3) found that this deportment is occasioned probably by a previous oxidation of the phosphorus, followed by the action of its products of oxidation upon the

(1) J. Pr. Chem. XLIV, 122.

(2) Grundr. d. Org. Chem. I. 400.

(3) Pogg. Ann. LXXV, 282; Ann. Ch. Pharm. LXIX, 180 (in abstr.); J. Pr. Chem. XLVI, 157.

Phosphethylic acid and phospho-biethylic acid.

ether(1). He farther observed, that by the action of anhydrous phosphoric acid upon ether or alcohol, or by the absorption, at the ordinary temperature, of the vapour of the latter by the former acid, another acid, besides phosphethylic acid, is formed, the baryta-, lead- and silver-salts of which are more soluble than those of phosphethylic acid. Incidentally to his investigation, Voegeli examined the composition of phosphethylate of protoxide of lead; he arrived at the formula $2\,PbO, C_4 H_5 O, PO_5$, and confirmed the formation of phosphethylic acid in the reaction of syrupy phosphoric acid upon ether. The acid previously mentioned, which Voegeli designates *phospho-biethylic acid,* when separated from its lead-salt by hydrosulphuric acid and concentrated to a syrup *in vacuo,* does not crystallize, and exhibits partial decomposition. The phospho-biethylate of lead is readily soluble in cold and more so in warm water; it is difficultly soluble in cold absolute alcohol, but at the temperature of 40° and in dilute alcohol, it dissolves rapidly; it crystallizes in anhydrous needles, in theine-like groups, or in satiny masses, having the composition $PbO, 2\,C_4 H_5 O, PO_5$. This salt fuses at 180° and solidifies at 175° to a crystalline mass; heated above the fusing-point, it is decomposed, with evolution of white fumes, of an agreeable ethereal odour. The lime-salt is readily soluble in water, somewhat difficultly in dilute and but slightly in absolute alcohol; it likewise crystallizes in anhydrous satiny groups, $CaO, 2\,C_4 H_5 O, PO_5$. The magnesia-salt only forms crystals with difficulty; the copper-salt cannot be obtained in the crystalline form, and the nickel-salt only in hydrated crystals; the three salts just mentioned are very soluble in water.

Phosphate of Oxide of Ethyl.—In the action of anhydrous phosphoric acid upon alcohol, and in the decomposition of the phospho-biethylates by heat, Voegeli noticed an agreeable ethereal odour; the body thus characterized is obtained as a limpid liquid, by distilling phospho-biethylate of lead in an oil-bath at from 180° to 190°. This compound, which is phosphate of oxide of ethyl $3\,C_4 H_5 O, PO_5$, is dried over freshly-ignited carbonate of potassa and rectified. It cannot be obtained perfectly anhydrous; the highest observed boiling-point(2) was 142°·5. The formation of

(1) Experiments made in the Giessen laboratory have likewise proved the inaccuracy of Zeise's statements.

(2) Voegeli determined the boiling-point by enclosing the substance in a tube over mercury, and ascertaining at what temperature its vapour counterbalanced the atmospheric pressure.

this substance from phospho-biethylate of lead is expressed by: $2\,(PbO, 2\,C_4\,H_5\,O, PO_5) = 3\,C_4\,H_5\,O, PO_5 + 2\,PbO, C_4H_5O, PO_5$. Sulpho-phosphe-thylic acid.

Sulphophosphethylic Acid.—Cloez(1) has stated, that by the action of sulphochloride of phosphorus ($P\,S_2\,Cl_3$) upon alcohol, sulphophosphethylic acid is formed, having the composition $C_4\,H_5\,O, 2\,HO, P\,O_3\,S_2$, analogous to phosphethylic acid. It forms crystallizable salts with baryta, lime, strontia, &c. The baryta-salt has the formula $2\,BaO, C_4\,H_5\,O, P\,O_3\,S_2 + HO$. The potassa- and soda-salt are readily obtained by decomposing chlorosulphophosphoric acid by an alcoholic solution of potassa or soda ($P\,Cl_3\,S_2 + C_4\,H_6\,O_2 + 5\,KO = 2\,KO, C_4\,H_5\,O, P\,O_3\,S_2 + 3\,KCl + HO$).

Mellithethylic Acid.—For this acid we refer to I. 381; for the ethyl-compounds of organic acids to the respective articles on the individual acids.

Acetal.—In the preparation of acetal, according to Liebig's direction, Stas(2) obtained a liquid whose boiling-point was by no means constant, but rose from 88^0 to 110^0, and partially dissolved in concentrated solution of potassa with formation of acetate of potassa. According to his statements this liquid is a mixture of acetic ether and the true acetal. He states that the latter in a state of purity and of a constant composition is best obtained in the following manner. Pieces of moistened pumice-stone, previously washed with hydrochloric acid and heated to redness, are placed with nearly absolute alcohol in a glass balloon of from 40 to 50 litres capacity, whose aperture is sufficiently wide to admit the hand and arm; as many open glass dishes as possible, and covered with a thin layer of platinum-black, are then placed upon the pumice-stone; the opening of the balloon is closed by a ground-glass plate, and the whole allowed to stand at a temperature not exceeding 20^0, until the alcohol is almost completely converted into acetic acid; 1 or 2 litres of spirit of wine of 60 per cent are now poured on the bottom of the balloon, which is again closed and allowed to stand as before, a quantity of air, however, being admitted from time to time. After fifteen or twenty days, the liquid under the pumice-stone, which should never be entirely covered, becomes thickened, and is then taken out and replaced by a corresponding quantity of alcohol of 60 per cent. When some litres of acid liquid have been thus obtained, it is neutralized with carbonate of potassa, and saturated with chloride

(1) Compt. Rend. XXIV, 388.

(2) Ann. Ch. Phys. [3] XIX, 146; J. Pr. Chem. XL, 340; Ann. Ch. Pharm. LXIV, 322 (in abstr.); Phil. Mag. [3] XXX, 220.

Acetal.

of calcium; or acetate of potassa is added as long as it dissolves, without previously neutralizing the liquid. It is now cautiously distilled, and the first fourth of the distillate collected in a well-cooled receiver. Addition of chloride of calcium immediately separates a considerable quantity of a very volatile liquid of a suffocating odour, which is then removed; a farther quantity separates on addition of water to the remainder, and a small additional portion may be still obtained by carefully distilling the residuary solution of chloride of calcium. The liquid thus obtained contains aldehyde, acetic ether, alcohol, and acetal. It is saturated with chloride of calcium, and distilled in a water-bath (the temperature being kept below the boiling-point) till the distillate ceases to reduce ammoniacal acetate of silver. In order to remove the acetic ether from the liquid thus freed from aldehyde, it is placed in contact during several days with a great excess of concentrated solution of potassa; the acetal is then washed, once or twice with an equal volume of water, dried by chloride of calcium, and rectified in contact with mercury or platinum wire (to avoid the bumping during ebullition). Acetal is thus obtained pure, as an ethereal colourless liquid, of a peculiar agreeable odour and refreshing taste, having a spec. grav. 0·821 at 22°·4, and boiling at from 104° to 106° at 768^{mm} barometric pressure. Analysis agrees with the formula $C_{12}\,H_{14}\,O_4$(1); its vapour-density was found to be from 4·069 to 4·240, the formula corresponds to a condensation to 4 vols., the theoretical number being 4·082. Hence it contains the elements of 2 equivs. of ether, and 1 equiv. of aldehyde; Stas, however, does not regard it as such a compound, but believes, that it arises from the union of 3 equivs. of ether, and the replacement of 1 equiv. of hydrogen by 1 equiv. of oxygen.—Acetal is dissolved at 25° in about 18 times its vol. of water, at a higher temperature it is less soluble; salts separate it from the solution. With ether and alcohol it mixes in all proportions, and from the latter solution it is separated by chloride of calcium only on addition of water. It appears to undergo no alteration in the air; platinum-black converts it rapidly into aldehyde, and subsequently into acetic acid; dilute nitric acid effects the same change, chromic acid produces only acetic acid, ammoniacal acetate of protoxide of silver and alkalies neither alter it in the cold nor with the co-operation of heat.—Acetal is likewise formed by the

(1) This formula has been confirmed in the Giessen Laboratory, by Dr. Price.

Acetal.

action of chlorine upon spirit of wine of 80 per cent cooled down to 10^0 or 15^0, the reaction being interrupted when substitution-products begin to be reproduced, *i. e.*, when addition of water causes a cloudiness; it is then distilled, and the acid liquid which passes over subjected to the above-mentioned treatment(1).

Amyl-Compounds. Hydrated Oxide of Amyl. Amyl-Ether?. Chloride of Amyl. Action of Cyanic Acid upon Hydrated Oxide of Amyl. Nitrite, Nitrate and Benzoate of Oxide of Amyl.—Rieckher(2) has prepared and investigated several amyl-compounds. He found the spec. grav. of hydrated oxide of amyl (fusel-alcohol) to be 0·8185 at 15^0, the boiling-point 134^0; he analysed a portion purified in the ordinary manner, as well as some which was regenerated from the benzoate, oxalate and acetate of oxide of amyl, the result agreeing with the formula $C_{10}\,H_{12}\,O_2$.—By distilling hydrated oxide of amyl with sulphuric acid he obtained a distillate of inconstant boiling-point, which could be separated by sulphuric acid into two substances, one insoluble, the other dissolving in the acid with a red colour; the latter, when separated by water from the sulphuric acid solution, presented itself as a liquid of inconstant boiling-point, yielding at 175^0 to 185^0 a distillate of the spec. grav. 0·779, and the composition of amylic ether ($C_{10}\,H_{11}\,O$).—He obtained chloride of amyl ($C_{10}\,H_{11}\,Cl$), by passing hydrochloric acid gas into hydrated oxide of amyl, (which became of a green colour), and distilling at the lowest possible temperature; the chloride of amyl which passed over was coloured amarynth-red by a portion of hydrochloric acid; when pure it boiled at 102^0.—By passing gaseous cyanic acid into hydrated oxide of amyl it caused its solidification into a thick magma of crystals, which were recrystallized from alcohol; they admitted of being sublimed between two watch glasses; the amount of nitrogen in these crystals agreed with the formula $3\,C_{10}\,H_{11}\,O,\,3\,HO,\,2\,Cy_3\,O_3$.—Rieckher prepared nitrite of oxide of amyl ($C_{10}\,H_{11}\,O,\,NO_3$) by passing nitrous acid into the hydrated oxide, distilling at the lowest possible temperature with a current of the acid passing simultaneously through the retort; by rectification and fractional distillation he obtained this compound of the spec. grav. 0·8773, and a boiling-point of 91^0.—Nitrate of oxide of amyl, ($C_{10}\,H_{11}\,O,\,NO_5$), was prepared by cautious distillation of hydrate of oxide of amyl and nitric acid, with addition of

(1) Dr. Price obtained a large quantity of acetal likewise from the residues of the preparation of aldehyde.

(2) Jahrb. Pr. Pharm. XIV, 1; Ann. Ch. Pharm. LXIV, 336 (in abstr.); J. Pharm. [3] XIV, 300.

Amyl-compounds.

urea or nitrate of ammonia; the pure compound possessed the spec. grav. 0·902 at 22°, and the boiling-point 137°(1).—Benzoate of oxide of amyl (C_{10} H_{11} O, C_{14} H_5 O_3) boils, according to his statements, between 252° and 254°.

Bisulphide of Amyl and Sulphocyanide of Amyl. — O. Henry, Jun.,(2) has prepared bisulphide and sulphocyanide of amyl. By distilling equal volumes of concentrated solutions of sulphamylate of potassa and bisulphide of potassium, a yellow, oily liquid of a powerful odour, floating upon the water, is obtained; when rectified over chloride of calcium, the first portion of the distillate (boiling towards 210°) is sulphide, while that which passes over subsequently (boiling between 240° and 260°) consists of bisulphide of amyl. The latter (C_{10} H_{11} S_2) is a fine amber-yellow liquid of the spec. grav. 0·918 at 18°, burning with a bright white flame, and possessing a strong garlic-like odour; it is not perceptibly acted upon by acids or alkalies.—Sulphocyanide of amyl was obtained by distilling equal volumes of crystallized sulphamylate of potassa and sulphocyanide of potassium; the pale-yellow oily liquid passing over with the water boiled between 170° and 260°, and had the spec. grav. 0·905 at 20°; the portion which, on rectification, had passed over between 195° and 210° exhibited a composition agreeing with the formula C_{12} H_{11} N S_2 = C_{10} H_{11}, C_2 N S_2; the vapour-density was found = 5·4, 6·0, and 6·6; assuming a condensation to 4 vols. calculation gives for it 4·5. Bisulphide as well as sulphocyanide of amyl yields, with nitric acid, sulphamylo-sulphuric acid, which was first prepared by Gerathewohl by the action of nitric acid upon amyl-mercaptan; the baryta-salt in the crystallized state, was found, in accordance with Gerathewohl's statement, to be BaO, C_{10} H_{11} S_2 O_4 + HO.

Sulphocyanide of amyl has been likewise examined by Medlock(3), who found its boiling-point to be constant at 197°, and its spec. grav. at 15·5°, 0·938. By treatment with nitric acid he obtained an acid corresponding to hyposulphomethylic and hyposulphethylic acids, and to which he assigns the name hyposulphamylic acid. Medlock analysed the salts of baryta, copper and lead, which are extremely soluble, but crystallizable. These salts, when dried at 100°, are

(1) P. W. Hofmann, who has likewise prepared and analysed nitrate of oxide of amyl, found its spec. grav. to be 0·994 at 10°, and its boiling-point at 148°; Ann. Ch. Phys. [3] XXIII, 332; Ann. Ch. Pharm. LXVIII, 332 (in abstr.); J. Pr. Chem. XLV, 358.

(2) Ann. Ch. Phys. [3] XXV, 246; Compt. Rend. XXVIII, 48 (in abstr.); Instit. 1849, 9; J. Pharm. [3] XIV, 247; J. Pr. Chem. XLVI, 160.

(3) Chem. Soc. Qu. J. I, 368.

represented by the formula MO, $C_{10} H_{11} S_2 O_5$. Hofmann(1) remarks, that sulphamylo-sulphuric acid, in which Gerathewohl found 1 equiv. of hydrogen more, is identical with the acid contained in these salts, inasmuch as their properties are exactly the same, and Gerathewohl's analysis gave less hydrogen than is required by his formula, comp. II. 26.

Bisulphide of amyl and sulphocyanide of amyl.

Cyanide of Amyl.—For Cyanide of amyl, and its decomposition by potassa, we refer to I. 430.

Sulphocarbonate of Amyl.—Desains(2) has prepared sulphocarbonate of amyl $C_{10} H_{11} O, C S_2$. Potassa and pure amyl-alcohol (fusel-oil) are carefully mixed; to the magma bisulphide of carbon is then added, the mixture being continually rubbed; an excess of amyl-alcohol must be avoided in the preparation. In this manner amylo-xanthonate of potassa is produced, to which water, and subsequently pulverised iodine is added. The amyl-compound $C_{12}H_{11}S_4O_2$ is directly formed as a yellow oil, corresponding to the ethyl-compound $C_6 H_5 S_4 O_2$, mentioned II. 18. Heated to 187° this oil commences to boil, sulphocarbonate of amyl distilling over, as an amber-coloured, strong smelling liquid.

New Alcohols in Wax.—The comparatively small number of hitherto known alcohols has been enriched by two new members (melissin = $C_{60} H_{62} O_2$, and cerotin = $C_{54} H_{56} O_2$), which Brodie has discovered in his persevering and important investigations upon bees-wax, and a wax from China. We shall communicate here the researches of Brodie upon these waxy bodies in general, including the results which he has obtained in the study of the constituents not belonging to the alcohol-series.

Examination of Bees-Wax.—The first communication of Brodie(3) relates to bees-wax. By treating wax with boiling alcohol(4) he was enabled to extract a substance (hitherto designated cerin), which is harder, and possesses a higher fusing-point than the residue (myricin). This substance is readily saponified by solution of caustic potassa; by decomposing the soap with an acid, preparing a baryta-

(1) Chem. Soc. Qu. J. I, 368.

(2) Loc. cit. II, 5.

(3) Phil. Mag. [3] XXXIII, 217; J. Pr. Chem. LXV, 335; Ann. Ch. Pharm. LXVII, 180; J. Pharm. [3] XV, 145 (in abstr.); Laurent and Gerhardt's Compt. Rend. des Trav. Chim. 1849, 50.

(4) Vogel, Jun., states that chloroform invariably dissolves a constant proportion of pure bees-wax (¼ of the whole), while a larger quantity is dissolved if bees-wax be adulterated with tallow or stearic acid. He finds that bees-wax yields to chloroform a soft viscid substance, the residue becoming granular and friable (Repert. Pharm. [3] II, 117.

Examination of bees-wax.

salt with the acid thus set free, and treating the latter after drying with ether, a certain quantity of a substance (cerain) is extracted, which is only slightly acted upon by potassa. Brodie believes, that cerain, which in larger quantity is found in the residue (the so-called myricin), is only an admixture of cerin prepared as above stated, and not a product of its decomposition, cerin being an acid ready formed in wax. Lewy's(1) statement, that by heating wax with lime and hydrate of potassa, it is converted into stearic acid, and the view of the constitution of wax subsequently founded on this experiment, have been refuted by Brodie.

For the preparation of the acid contained in wax, which Brodie names *cerotic acid,* he gives the following direction. Bees-wax is exhausted four or five times with strong spirit of wine, and the liquid poured off from the residue while hot; the precipitate formed on cooling is repeatedly treated with alcohol in the same manner, until the substance thus separated fuses at about 70°. This substance is then completely dissolved in a large amount of boiling alcohol, precipitated with a boiling solution of acetate of protoxide of lead, and boiled and filtered while hot; the precipitate, still moist, is again boiled with alcohol and then with ether, the process being frequently repeated until these solvents cease to extract anything farther from the precipitate. The lead-salt thus purified, is then decomposed with strong acetic acid; the cerotic acid which separates is well washed with boiling water, dissolved in hot absolute alcohol, and the solution filtered while hot; on cooling, the cerotic acid separates in granular crystals. The acid thus prepared may be still farther purified by again boiling with potassa, precipitating the baryta-salt by addition of a large amount of chloride of barium and carbonate of soda, washing the precipitate with ether, decomposing it again by an acid, and subsequently recrystallizing the acid thus obtained once more from alcohol. Cerotic acid fuses at 78° to 79°, becoming crystalline on cooling; its composition was found to agree with the formula $C_{54}\,H_{54}\,O_4$, which was also confirmed by the analysis of the silver-salt, $AgO,\,C_{54}\,H_{53}\,O_3$, and of its ether, $C_4\,H_5\,O,\,C_{54}\,H_{53}\,O_3$. The former was prepared by precipitating the ammoniacal alcoholic solution of the acid by an alcoholic solution of nitrate of protoxide of silver, the latter, as a waxy mass, fusing at from 59° to 60°, by the action of hydrochloric acid gas upon a solution of the acid in absolute alcohol.—If chlorine be passed over fused cerotic acid for several days, until hydrochloric acid ceases to be evolved, a

(1) Ann. Chem. Phys. [3] XIII, 439; Berzelius' Jahresber. XXIV, 468.

Examination of bees-wax.

transparent, yellowish, gummy mass is produced, which admits of being drawn into threads; it has the composition $C_{54}\ H_{42}\ Cl_{12}\ O_4$. Brodie terms it *chlorocerotic acid.* It forms an ether, $C_4\ H_5\ O$, $C_{54}\ H_{41}\ Cl_{12}\ O_3$, which is obtained by a process similar to that for cerotic ether.—Pure cerotic acid can be distilled without decomposition, but in an impure state, (as the so-called cerin), it is decomposed. Cerin, which fused at 70°, yielded on distillation, first an oily product, and towards the end of the operation, a solid substance. By standing, the oil thus obtained, separated into two layers; the lower (about $\frac{1}{20}$ of the whole) was removed and the upper portion boiled with potassa, which, however, took up but very little acid. The oil thus treated dissolved almost entirely in alcohol, leaving, as residue, a small quantity of a solid body, resembling paraffine; it was a mixture of different oils, and on distillation the boiling-point rose continually. Brodie analysed, firstly, that which passed over from 210° to 220°; secondly, that from 220° to 230° (at which temperature the largest quantity distilled over); and thirdly, that from 230° to 250°; he found the following numbers:

	I.	II.	III.
Carbon . .	84·17	84·30	85·37
Hydrogen . .	13·73	14·05	14·05
Oxygen . .	2·10	1·65	0·58

according to which, it appears that the higher the boiling-point, the smaller the amount of oxygen contained in the distillate. Brodie farther states, that another acid is contained in the alcoholic mother-liquor, from which cerotic acid has crystallized; an alcoholic solution of acetate of protoxide of lead produces a precipitate in this solution, distinguished from cerotate of lead by dissolving again on ebullition in the alcoholic liquid and separating on cooling in crystalline grains. This acid resembles margaric acid, and likewise approaches it in composition; it is, however, contained in the wax in so small a proportion, that Brodie could not obtain it in sufficient quantity for a more minute investigation. In a variety of English wax, Brodie found 22 per cent of cerotic acid; in bees-wax from Ceylon, on the other hand, none whatever.

The residue of the treatment of wax with alchohol, the so-called myricin, has likewise been investigated by Brodie(1). It is somewhat green, of the consistence of wax, and fuses at 64°. It is attacked only with difficulty by dilute solution of potassa, but by continued

(1) Phil. Trans. for 1848, I; J. Pharm. [3] XVI, 66.

Examination of bees-wax.

boiling with a concentrated ley, or better with a concentrated alcoholic solution, or by fusion with hydrate of potassa, it is saponified; in the process of saponification an acid combines with the potassa, and a body is set free, which belongs to the series of alcohols.

The purification of the acid and of the new alcohol is exceedingly difficult; both are mixed with other substances which are contained previously in the myricin or are formed during the saponification. The method adopted by Brodie for preparing the acid and the alcohol consists in dissolving the potassa-soap in a large amount of water, boiling, and decomposing the boiling solution with hydrochloric acid; the fused mass which separates from the liquid is exhausted with boiling water and dissolved in a large quantity of alcohol; the alcoholic body almost entirely separates from the solution on cooling, while the acid remains in solution. The alcohol thus prepared is not yet pure; it is dissolved in hot naphtha, from which solution it is deposited on cooling in a purer state. The substance thus prepared, belongs to the alcohols, and has been termed by Brodie *melissin*; it fuses at 85°, and contains $C_{60}\,H_{62}\,O_2$.—Heated with lime and hydrate of potassa, melissin evolves hydrogen and is converted into mellissic acid $C_{60}\,H_{60}\,O_4$, which fuses at from 88° to 89°. By the action of chlorine, melissin loses 2 eq. of hydrogen, which are not replaced, another portion, however, of hydrogen being substituted by chlorine. Brodie analysed such a compound, whose composition was expressed by $C_{60}\,H_{45\cdot5}\,Cl_{14\cdot5}\,O_2$; he assigned to it the name *chloromelal*.

By evaporation of the alcoholic liquid from which the melissin has been separated, the acid contained in the myricin is deposited. To prepare it in the pure state, the first crystals which are thus separated, are collected and combined with potassa; the potassa-soap is decomposed with chloride of barium and the baryta-salt treated with ether. Hydrochloric acid separates from the baryta-salt thus purified a fatty acid, which resembles margaric or palmitic acid; by frequent recrystallization from ether, its fusing-point rises to 62°, and both composition and properties of the acid show that it is palmitic acid $C_{32}\,H_{32}\,O_4$.

The purified myricin may be viewed as being composed according to the formula $C_{92}\,H_{92}\,O_4 = C_{60}\,H_{61}\,O,\,C_{32}\,H_{31}\,O_3$, *i. e.* as a compound of the palmitic acid with the ether of the melissin-alcohol. The purification of myricin is effected only with difficulty by repeated recrystallization of the impure myricin from alcohol and then from naphtha; the myricin is finally obtained in crystals united in clusters, which are only difficultly soluble in alcohol and fuse at 87°·5.

Among the substances contained in the impure myricin, Brodie has pointed out an acid which accompanies the melissin and remains in solution on the recrystallization of the latter from ether or naphtha; this acid appears to belong to the series of acids $C_n H_n O_4$; its composition was found to be $C_{49} H_{49} O_4$, which formula, however, is even by Brodie, considered as doubtful. Examination of bees-wax.

In the distillation of myricin, solid fatty acids pass over first, and finally hydrocarbons(1). The product of distillation was exhausted with boiling water, treated with potassa, the hydrocarbons, which are not saponified, being separated from the potassa-salt. This potassa-salt contains palmitic acid. By solution of the hydrocarbons in ether and repeated recrystallization from this solvent, a solid hydrocarbon is finally obtained, which fuses at 56° and contains equal equivalents of carbon and hydrogen. Brodie assigns to it the formula $C_{60} H_{60}$, and the term *melen*.

Examination of Chinese Wax.—Another communication of Brodie's(2) has for its object the investigation of a kind of wax, imported from China. It is usually regarded as a vegetal wax, but Brodie considers it probable that it is likewise secreted by an insect. This wax resembles, in its external appearance, spermaceti; it fuses at about 83°; alcohol extracts from it only a very small quantity of a fatty substance, and when distilled, it yields only traces of acrolein.

This wax is not perceptibly attacked by boiling with dilute or concentrated solution of potassa: by fusion with hydrate of potassa, however, it is rapidly decomposed, a mass being formed, which yields a milky solution with water. When this solution is precipitated by chloride of barium and the resulting precipitate (which contains likewise the baryta-salt of the acid existing in the wax, of cerotic acid) treated with alcohol or ether, a substance is extracted, which Brodie designates *cerotin*, and which, when recrystallized from alcohol or ether until it fuses at 79°, has the composition $C_{54} H_{56} O_2$, which is that of an alcohol. When treated with potassa-lime, cerotin evolves hydrogen, and is converted into cerotic acid $C_{54} H_{54} O_4$, which prepared in this manner, exhibits a fusing-point of 81°. If concentrated sulphuric acid be allowed to act in the cold,

(1) Respecting the products of distillation of bees-wax, Poleck states that the volatile acid which passes over is a mixture of acetic and metacetonic acid, while the solid acid contains probably margaric and palmitic acids. (Ann. Ch. Pharm. LXVII, 174.)

(2) Phil. Mag. [3] XXXIII, 378; Ann. Ch. Pharm. LXVII, 199; J. Pr. Chem. XLVI, 30; J. Pharm. [3] XV, 147 (in abstr.); Laurent and Gerhardt's Compt. Rend. des Trav. Chim. 1849, 53.

Examination of Chinese wax.

for several days upon finely divided cerotin (so that the whole mixture forms a thin paste) *sulphate of oxide of cerotyl* is formed; the mass thus obtained is then thrown into cold water, washed, dried *in vacuo*, and crystallized from ether. This compound is soluble in water, especially when containing some spirit, and has the composition $C_{54} H_{55} O, SO_3$ (the amount of sulphur, however, was not determined in the analysis).—By the action of chlorine upon fused cerotin, a transparent, yellowish, gummy body is formed, whose composition was found to agree closely with the formula $C_{54} H_{41} Cl_{13} O_2$, and which Brodie designates *chloro-cerotal*, with reference to its analogy with chloral, in whose formation, likewise, 2 eq. of hydrogen are eliminated from the alcohol without substitution.—In the distillation of cerotin, a colourless solid body is obtained, whose fusing-point, by recrystallization, was raised from 70° to 79°. Brodie believes that part of the cerotin volatilizes without decomposition, while another portion is decomposed into a solid carbohydrogen and water.

The wax itself—recrystallized from alcohol and naphtha, washed with ether, boiled with water and again recrystallized from absolute alcohol—fuses at 82°, its composition being expressed by $C_{108} H_{108} O_4 = C_{54} H_{55} O, C_{54} H_{53} O_3$, *i. e.*, cerotate of oxide of cerotyl.—In the distillation of wax, cerotic acid passes over first, and subsequently a substance, upon which potassa has no action and which may thus be freed from cerotic acid. This substance principally consists of a solid hydrocarbon, which may be obtained in a purer state by separating an accompanying oil by pressure between bibulous paper and crystallization from naphthalized alcohol and subsequently from ether; it fuses then at from 57° to 58°, and contains $C_{54} H_{54}$; Brodie terms it *ceroten*.—Chlorine very slowly converts ceroten into a transparent resin, in which, according to the duration of the action, a larger quantity of hydrogen in the ceroten is replaced by chlorine, (the specimen richest in chlorine had the composition $C_{54} H_{32} Cl_{22}$). —Ceroten is entirely converted into a liquid when repeatedly distilled in a curved sealed tube from one end to the other.

Volatile Oils, Camphor, Balsams, Resins and Collateral Matters. Volatile Oils in General.—Van Hees(1) has made the following communication respecting the produce of ethereal oils and their specific gravities (at 15° ?). The oils heavier than water were prepared by surrounding the still with high-pressure steam, those which were lighter, by passing steam through the plants.

(1) Pharm. Centr. 1847, 380.

			Spec. grav.
Oleum anisi	20 lbs. gave	5¼ oz.	0·977
Ol. anisi stellati	20 lbs gave	8 „	0·976
Ol. calam arom.	(old oil)		0·984
„ „ „	55 lbs. calamus of a previous year, gave	12 „	0·956
„ „ „	85 lbs. new calamus, somewhat dried, gave	10 „	0·950
Ol. carui	12½ lbs. of the last year's seeds, gave	8 „	0·923
„ „	25 lbs. fresh seeds from the Eifel, gave	17 „	0·913
„ „	⅛ cwt. Saxony seeds, gave	6 „	0·926
Ol. caryophyll.	10 lbs. Amboina cloves gave by 6 distillations	31 „	1·040
„ „	8 lbs. Bourbon cloves, gave	21 „	1·035
„ „	25 lbs. Dutch cloves gave by 8 distillations	74 „	1·033
„ „	¼ cwt. clove-stems, gave	16 „	1·049
Ol. cass. cinnam.	⅛ cwt. bruised cinnamon, gave	2¾ „	1·035
Ol. cass. flor.	12½ lbs. gave	3⅛ „	1·023
Ol. foenic.	10 lbs. gave	5 „	0·968
Ol. junip. bacc.	44 lbs. dried ripe berries, gave	2¼ „	0·870
„ „ „	96 lbs. fresh „ „ „	7⅛ „	0·862
„ „ „	53 lbs. unripe „ „ „	3 „	0·864
Ol. lavendulæ	⅛ cwt. dried flowers „	2 „	0·892

Deportment of Volatile Oils with Iodine.—Will(1) has observed, that by adding anise- or fennel-oil, drop by drop, to a cold saturated solution of iodine, in an aqueous solution of iodide of potassium, the mixture being agitated, a gelatinous magma is produced, which, on addition of 6 or 8 times its volume of alcohol, yields a pulverulent body, becoming of a dazzling white when washed with alcohol. He has made a farther investigation upon the subject in conjunction with Rhodius, according to which, anise- and fennel-oil comport themselves, with a similar iodine-solution, exactly in the same manner (oil of fennel yields 54·8 per cent of its weight of a solid product); but with the oils of cumin, wormwood, chamomile, tansy, rue, clove, and peppermint, similar solid products could not be obtained by the same process. The substance prepared with fennel- or anise-oil, is in the state of purity, a brilliant, white, non-crystalline, very light, and highly electric powder, which fuses at 100°, and becomes vitreous on cooling; it is completely volatilized at high temperatures, with evolution of an odour resembling that of anise-oil, even when prepared from fennel-oil. It is insoluble in water and alcohol, moderately soluble in ether, from which solution it may be precipitated by alcohol. Potassa, ammonia, dilute sulphuric- and hydrochloric acid are without action upon it, even at the boiling temperature; concentrated nitric acid decomposes it only on continuous ebullition; concentrated sulphuric acid colours it imme-

(1) Ann. Ch. Pharm. LXV, 230.

Deportment of volatile oils with iodine.

diately dark brown-red; on heating, a red solution is formed, which becomes colourless by dilution with water. It is free from iodine; analysis led to the following composition:

	From fennel-oil.			From anise-oil.	$C_{30}H_{18}O_4$	$C_{30}H_{19}O_4$
Carbon . .	77·9	78·0	77·7	77·2	78·2	78·0
Hydrogen .	—	8·2	8·5	8·5	7·8	8·2
Oxygen . .	—	13·8	13·8	14·3	13·9	13·8

The formula, $C_{30}H_{18}O_4$, is more probable, inasmuch as the formation of this compound may be understood by assuming that 3 equivs. of the stearoptene of the fennel- and anise-oil (according to Blanchet and Sell, $C_{10}H_6O$) unite with 1 equiv. of oxygen.—By passing chlorine, at a gentle temperature, over this body it becomes of a violet colour, heat being evolved, while absorption of chlorine, and evolution of hydrochloric acid gas takes place; if the action be conducted at 100°, the substance exhibits no coloration. The body obtained by the latter method presents the composition:

	From fennel-oil.	From anise-oil.	$C_{30}H_{15}Cl_3O_4$
Carbon . . .	52·7	51·5	54·0
Hydrogen . .	4·7	4·8	4·5
Chlorine . . .	31·9	32·7	31·6
Oxygen . . .	10·7	11·0	9·9

Accordingly the compound in question may be considered as $C_{30}H_{18}O_4$, in which 3 H, and probably somewhat more, are replaced by chlorine.

Bitter Almond-oil.—Lepage(1) confirms the statement of Winckler, that the fresh leaves of laurel contain bitter almond-oil and hydrocyanic acid ready-formed, and that both are entirely dissipated by dessication. The dried leaves, however, still contain a substance which may be extracted by hot water, or better by alcohol (Winckler's amorphous amygdalin); which, when treated with almond-emulsion, again yields hydrocyanic acid, and oil of bitter almonds; hence these two compounds are still found in the distillate of this substance, in far smaller quantity, however, than in the distillate of the fresh leaves.

According to Cahours(2), when bitter almond-oil (hydride of benzoyl) is heated with pentachloride of phosphorus two compounds distil over, one of which, boiling at 110°, is oxichloride of phosphorus PCl_3O_2, discovered by Wurtz; the other, which commences

(1) J. Chim. Méd. [3] IV, 565. (2) Loc. cit. I. 276.

Bitter almond-oil. Benzole.

to boil only at 206°, and has been termed *chlorobenzole,* is $C_{14} H_6 O_2$, being bitter almond-oil in which the oxygen is replaced by chlorine ($P Cl_5 + C_{14} H_6 O_2 = P Cl_3 O_2 + C_{14} H_6 Cl_2$). Chlorobenzole is a colourless, transparent liquid, of a penetrating odour when heated, and having the spec. grav. 1·245 at 16°; its observed vapour-density is 5·649, calculation gives for a condensation to 4 vols. the number 5·595; it is insoluble in water, readily soluble in alcohol and ether, and is not decomposed by solution of potassa.—With an alcoholic solution of hydrosulphate of sulphide of potassium, chlorobenzole is decomposed into chloride of potassium and a white body, *sulphobenzole,* which is fusible at 60°. This compound crystallizes from alcohol in brilliant scales; it is not volatile without decomposition, and yields, by treatment with nitric acid, sulphuric acid and a yellow crystalline body soluble in the alkalies. Sulphobenzole is $C_{14} H_6 S_2$, *i. e.,* bitter almond-oil, in which the oxygen is replaced by sulphur.

Benzole.—Mansfield(1) has found benzole in considerable quantity in that portion of the distillate of coal-tar-naphtha which first passes over and floats upon water. He subjected this portion to repeated fractional distillation, and exposed the distillate boiling between 80° and 90° to a temperature of from — 10° to — 12°, when part of it solidified into a crystalline mass. The portion remaining liquid at this temperature, or which liquified after heating to about 0°, was separated by pressure from the crystalline solid. This solid is benzole, whose boiling-point Mansfield observed to be between 80° and 81°; the spec. grav. of the coal-tar-benzole was found to be = 0·85, its vapour-density 2·823. Mansfield enters into full details respecting the applicability of benzole to practical purposes, and describes the process best adapted to separate it on a large scale from coal-tar-naphtha. An investigation of the other constituents of the volatile portion which floats upon water has been promised for a future period. From his preliminary statements we here communicate only, that after repeated fractional distillations, the portion boiling from 100° to 115°, contains toluole ($C_{14} H_8$), the oil boiling from 140° to 145° cumole ($C_{18} H_{12}$), and that the portion boiling between 170° and 175° is probably cymole ($C_{20} H_{14}$).

Abel(2) did not succeed in converting benzole by processes of

(1) Chem. Soc. Qu. J. I, 244; Ann.Ch. Pharm. LXIX, 162.
(2) Loc. cit. II. 36 sub (2).

Cinnamon-oil, Cumin-oil.

oxidation into an acid. Chromic acid, and the mixture of bichromate of potassa and sulphuric acid have no action upon it; nitric acid, even very dilute, converts it slowly into nitrobenzole.

Cinnamon-Oil.—According to Cahours(1) the products obtained by the action of pentachloride of phosphorus on cinnamon-oil are rather complex, and do not admit of being readily investigated; a large amount of hydrochloric acid is evolved, the mass becoming viscid, and finally black with intumescence.

Cumin-Oil.—Cumin-oil, as is well known, consists of two oils, of which the one, cuminole, containing oxygen (C_{20} H_{12} O_2), is converted by treatment with potassa into cuminic acid (C_{20} H_{12} O_4), from which cumole C_{18} H_{12} is obtained by distillation with baryta or lime; the other constituent, free from oxygen, is cymole (C_{20} H_{14}). During the last two years, investigations have been published upon the action of nitric acid, both on cumole and cymole.

Action of Nitric Acid upon Cumole.—Abel(2) has studied the products of oxidation which cumole yields when subjected to the action of nitric acid. He obtained cumole by distilling cuminic acid with 4 times its weight of caustic lime in a copper retort, the temperature being raised to a red heat towards the end of the operation; the distillate was rectified over potassa, and an unpleasant empyreumatic odour was removed by distillation with a concentrated solution of chromic acid. Cumole (C_{18} H_{12}), when dried over chloride of calcium, exhibited a boiling-point of 148°. By boiling with nitric acid it is rapidly converted into a heavy oil [nitrocumole $C_{18}H_{11}$ (NO_4)], which, by continued ebullition, again disappears, being gradually transformed into a yellowish crystalline mass, which is almost perfectly soluble in ammonia, leaving only a slight solid residue [binitrocumole $C_{18}H_{10}$ $(NO_4)_2$]. Addition of hydrochloric acid to the ammoniacal solution separates a white precipitate, which is slightly soluble in cold water, and dissolves pretty freely in hot water; from the latter solution it crystallizes on cooling. This product is nitrobenzoic acid C_{14} H_5 (NO_4) O_4, which is obtained, however, in a state of purity only, if cumole be distilled for several days with fuming nitric acid.—On treating cumole for several days with nitric acid, so dilute that no red vapours are evolved on ebullition, this hydrocarbon is converted into benzoic acid (C_{14} H_6 O_4).

(1) Loc. cit. I. 276.

(2) Phil. Mag. [3] XXXII, 63; Chem. Soc. Mem. III, 441; Ann. Ch. Pharm. LXIII, 308; J. Pr. Chem. XLIV, 148.

Action of nitric acid upon cymole.

Action of Nitric Acid upon Cymole.—Noad(1) has studied the action of nitric acid upon cymole (C_{20} H_{14}). In the preparation of this substance(2) the first two-thirds of the distillate of cumin-oil were repeatedly rectified over fused potassa, until, by this treatment no farther diminution was effected, (a copper retort is most suitable, glass vessels being strongly attacked by the potassa). The spec. grav. of cymole, dried by chloride of calcium, was found by Noad to be 0·8576 at 16°, and the boiling-point 171°·5. The preparation of cymole by the action of anhydrous phosphoric acid upon camphor is not to be recommended, it yields only a trifling proportion. Cymole remains unaltered by continued treatment with chromic acid, or with binoxide of manganese and sulphuric acid. Permanganic acid acts rapidly upon it, but no acid appears to be formed.

If half a kilogramme of dilute nitric acid (ordinary acid mixed with 6 times its volume of water) be repeatedly distilled with about 125 grms. of cymole the oxidation proceeds quietly and slowly; the oil first assumes a blue colour by absorption of binoxide of nitrogen, and subsequently a dark yellow; after the distillate has been returned to the retort from twenty to thirty times, the oil becomes heavy and viscid, and sinks to the bottom of the retort; the operation is completed (after two or three days), when, instead of oily droplets, white crystals commence floating upon the water in the receiver. On cooling, the whole retort becomes filled with crystals, the purer and whiter, the higher the dilution of the nitric acid employed. If concentrated nitric acid be used, violent reaction ensues at the boiling-point of the mixture, and the acid which is formed invariably contains a considerable quantity of the nitrotoluylic acid, which will be described below; small quantities of the latter are formed even if dilute nitric acid be employed. In order to purify the new acid it is washed with water, boiled with milk of lime, and filtered, a yellow resinous matter being thus separated; the cooled solution of the lime-salt is decomposed with hydrochloric or nitric acid, the operation being repeated until the acid is perfectly white; it is then dissolved in baryta-water, the solution evaporated to dryness in the water-bath, and the dried salt-mass treated with cold water, when a small quantity of nitrotoluylate of baryta remains

(1) Phil. Mag. [3] XXXII, 15; Chem. Soc. Mem. III, 421; Ann. Ch. Pharm. LXIII, 281; J. Pr. Chem. XLIV, 145; J. Pharm. [3] XIII, 74.

(2) Noad mentions that Warington (who supplied the necessary cumin-oil) obtained from 84lbs. of cumin-seeds in 4 distillations 2 lbs. 12oz. of oil, yielding, according to the described process, 18 oz. of pure cymole.

Action of nitric acid upon cymole.

undissolved; the nearly pure baryta-salt thus obtained is repeatedly subjected to this operation, until it no longer exhibits the presence of a trace of insoluble salt. The acid precipitated from the pure baryta-salt, when washed and recrystallized is pure *toluylic acid* $C_{16} H_8 O_4$, which is isomeric with hydride of anisyl and with benzoate of oxide of methyl. This acid, when separated by hydrochloric or nitric acid from one of its salts, is a heavy, white, curdy mass, consisting of microscopic needle-shaped crystals; it dissolves copiously in boiling water, and crystallizes therefrom on cooling; wood-spirit, alcohol, and ether, dissolve it in almost every proportion; when heated, it fuses and sublimes undecomposed in beautiful needles; when perfectly pure it is inodorous and tasteless, but even from acid which is nearly pure, a peculiarly offensive odour is evolved. The baryta-, silver-, and copper-salts have been examined quantitatively—the baryta-salt prepared exactly as stated could not be obtained in distinct crystals; the silver-salt, obtained as a white curdy precipitate, on addition of toluylate of ammonia to nitrate of protoxide of silver, crystallizes from a hot aqueous solution in small needles; the copper-salt, prepared by adding sulphate of protoxide of copper to toluylate of potassa, is a bright-blue precipitate only slightly soluble in water, which dissolves more readily in ammonia, a deep blue liquid being formed; the composition of these salts is $MO, C_{16} H_7 O_3$. Toluylate of oxide of ethyl $C_4 H_5 O, C_{16} H_7 O_3$ is a colourless aromatic liquid, which boils at 228° (19° higher than benzoate of oxide of ethyl $C_4 H_5 O, C_{14} H_5 O_3$); it is obtained by saturating an alcoholic solution of the acid with hydrochloric acid gas, distilling off $\frac{2}{3}$ of the liquid, adding water to the residue, digesting the heavy black oil which separates with ammonia, washing with water, digesting with chloride of calcium and rectifying. The potassa-salt is very soluble, and crystallizes only with difficulty in needles; the soda-salt is still more soluble, and cannot be obtained in crystals; the ammonia-salt crystallizes in small prisms, and the lime-salt from a concentrated aqueous solution, in long brilliant needles.—Toluylic acid, when distilled with a large excess of caustic baryta yields toluole ($C_{14} H_8$), whose boiling-point Noad found to be from 109° to 110°·5(1).

When cymole is distilled with fuming nitric acid a violent reaction takes place; if the distillation be continued as long as red

(1) A. W. Hofmann remarks, in a note to Noad's paper, that Glenard and Boudault's dracyl is not only isomeric but identical with toluole ($C_{14} H_8$), inasmuch as nitrotoluole, and subsequently toluidine, may be prepared from it.

Action of nitric acid upon cymole.

vapours are evolved, a crystalline mass of nitrotoluylic acid separates on the cooling of the retort, and an additional copious precipitate is produced on mixing the liquid with water. Unless the acid employed be of the highest concentration an indifferent crystalline body is formed, which can be converted into nitrotoluylic acid only with difficulty. The whole crystalline mass is thrown upon a filter, washed with cold water and subsequently with ammonia, when the greater portion dissolves, only a minute quantity of an oily substance remaining behind. The newly formed acid is precipitated from the ammoniacal solution by hydrochloric acid, washed with cold water, dissolved in hot alcohol, heated to ebullition with animal charcoal, and crystallized by spontaneous evaporation. Nitrotoluylic acid $C_{16}\ H_7\ (NO_4)\ O_4$ [toluylic acid, in which 1 equiv. of H is replaced by 1 (NO_4)] crystallizes in splendid, pale-yellow rhombic prisms. The baryta-, silver-, and lime-salt of this acid have been quantitively investigated. The baryta-salt is thrown down, on addition of the ammonia-salt to a solution of chloride of barium, as a white curdy precipitate readily soluble in boiling water, and deposited from this solution on cooling in stellated clusters of crystals; the silver-salt is obtained by decomposing the ammonia-salt with nitrate of silver, in form of a curdy precipitate separating, on cooling, from its solution in hot water, in feathery crystals, which are only slightly soluble in alcohol, and blacken by continued ebullition with water; the lime-salt prepared in a similar manner is a crystalline precipitate crystallizing from the aqueous solution in groups of oblique rhombic columns. The composition of these salts is $MO,\ C_{16}\ H_6\ (NO_4)\ O_3$. Nitrotoluylate of oxide of ethyl $C_4\ H_5\ O,\ C_{16}\ H_6\ (NO_4)\ O_3$, and Nitrotoluylate of oxide of methyl $C_2\ H_3\ O,\ C_{16}\ H_6\ (NO_4)\ O_3$, have likewise been examined; the former is obtained by distilling an alcoholic solution of the acid, saturated with hydrochloric acid gas, until the distillate becomes milky on addition of water, treating the heavy, yellow, oily residue, which solidifies with crystalline structure on cooling with carbonate of potassa, washing with water, and recrystallizing from alcohol; it is of a pale-yellow colour, and of an agreeable odour; it fuses in the water-bath, and forms crystals again only slowly; the latter is prepared in a similar manner, for its complete purification, however, ebullition with strong nitric acid is neccesary; this compound, too, is crystalline at the ordinary temperature. The observations respecting the toluylates of potassa and soda apply also to the corresponding nitrotoluylates. The ammonia-salt crystallizes from the aqueous solution in long needles, and loses the whole of its ammonia by boiling with animal charcoal; the neutral am-

Roman cumin-oil.

monia-salt yields with sulphate of protoxide of copper a basic copper-salt.—A mixture of fuming sulphuric and nitric acids has no action upon nitrotoluylic acid.

Roman Cumin-Oil.—According to Cahours(1), Roman cumin-oil, by distillation with pentachloride of phosphorus, yields, in addition to oxichloride of phosphorus, a colourless liquid, distilling between 255° to 260°, insoluble in water, but readily soluble in alcohol and ether; it is *chlorocuminole* $C_{20}H_{12}Cl_2$, *i. e.*, Roman cumin-oil in which the oxygen is replaced by chlorine ($C_{20}H_{12}O_2 + PCl_5 = PCl_3O_2 + C_{20}H_{12}Cl_2$). Chlorocuminole yields with an alcoholic solution of hydrosulphate of sulphide of potassium, chloride of potassium and a viscid body of an unpleasant odour.

Roman Chamomile-oil.—Gerhardt(2) has communicated investigations upon Roman chamomile-oil and oil of rue.—Roman chamomile-oil (from *Anthemis nobilis*) is greenish, and of an agrecable odour; it commences to boil at 160°, but the boiling-point gradually rises to 180°, and even to 190°, where it remains stationary for some time, and at which temperature about $\frac{2}{3}$ of the oil distil over. The boiling-point finally rises to 210°, owing to the presence in the oil of resinous constituents. In the portion distilling over between 200° and 210°, were found 75·6 to 76·0 per cent of carbon, 10·6 to 10·8 of hydrogen, and 13·2 to 13·9 of oxygen. This oil cannot be separated into proximate constituents by fractional distillation. It is not acted upon by aqueous solution of potassa, but when gently heated with powdered hydrate of potassa, the whole is rapidly, and without evolution of gas, converted into a gelatinous mass, unchanged oil being separated again on addition of water. But if the gelatinous mass be heated more strongly, or if Roman chamomile-oil be heated with an alcoholic solution of potassa, the oil is split into an oxygenated compound, which undergoes higher oxidation, and a carbohydrogen. By fusing the oil with an excess of potassa the mass strongly intumesces, with evolution of hydrogen, and simultaneously a carbohydrogen of an agreeable odour passes over; by supersaturating the residuary mass with sulphuric acid, acid vapours of angelic acid ($C_{10}H_8O_4$) are evolved, which readily condense in the form of needles. It is owing to the presence of a portion of this acid, that Roman chamomile-oil presents an acid reaction. If Roman chamomile-oil be boiled for some minutes with

(1) Loc. cit. I. 276.

(2) Ann. Ch. Phys. [3] XXIV, 96; J. Pr. Chem. XLV, 321; Ann. Ch. Pharm. LXVII, 235; Chem. Gaz. 1848, 483; Compt. Rend. XXVI, 225 (in abstr.)

Roman chamomile-oil.

an alcoholic solution of potassa, the oxygenated constituent unites with the potassa, the carbohydrogen only remaining in solution; on now distilling the dry residue with sulphuric acid, valerianic acid ($C_{10} H_{10} O_4$) passes over. The carbohydrogen which distils over in the action of solid potassa on the oil, or separates on addition of water and chloride of calcium to the distillate, after treatment with alcoholic solution of potassa, is purified by rectification over potassium; it has an agreeable lemon-like odour, and boils at 175°; its composition is $C_{10} H_8$; it yields no conjugated compound with fuming sulphuric acid. Gerhardt is of opinion, that the oxygenated compound which, together with the carbohydrogen, constitutes Roman chamomile-oil, is $C_{10} H_8 O_2$, *i. e.* the aldehyde of angelic acid.

Rue-oil.—Will(1) had found for oil of rue (from *Ruta graveolens*) the composition $C_{28} H_{28} O_3$. According to his determination of the vapour-density, this formula would represent a condensation to 4 vols.; the boiling-point, however, was observed to vary between 218° and 245°.—On these data, Gerhardt(2) had expressed his opinion, that oil of rue in the state of purity might be $C_{20} H_{20} O_2$, and isomeric with the stearoptene of peppermint-oil.—Cahours(3) has pointed out that oil of rue, when repeatedly rectified, boils constantly at from 228° to 230°, and crystallizes at — 1° to — 2°, in brilliant plates; he has found, moreover, that it has actually the composition $C_{20} H_{20} O_2$, and a vapour-density representing a condensation to 4 vols. This oil is converted, by concentrated nitric acid, into an oily volatile acid, $C_{20} H_{20} O_4$, which Cahours terms rutic acid, and of which the oil may be considered as the aldehyde.—Gerhardt has subsequently observed, that the oil commences to boil at 218°, the boiling-point rising to 236°, where it remains nearly stationary; the distillate boils at 233°. In the first portion which passed over he found 77·7 per cent of carbon, 12·8 hydrogen, 9·5 of oxygen, numbers which do not agree with any formula, while, on the contrary, the composition of the latter third which passed over in the distillation, was in accordance with the formula $C_{20} H_{20} O_2$. Oil of rue combines with a mixture of lime and potassa; this compound may be heated to 290° without evolution of gas, the mass becomes yellowish and yields again the unchanged oil, when dissolved in hydrochloric acid. By passing the vapour over fused chloride

(1) Ann. Ch. Pharm. XXXV, 235; Berzelius' Jahresbericht, XXI, 351.
(2) Précis de Chimie Organique, II, 153.
(3) Thèse de Chimie, présentée à la Faculté des Sciences de Paris, 1845.

Rue-oil.

of zinc a carbohydrogen is formed, whose composition has not yet been investigated. By dissolving the oxygenated constituent of the oil ($C_{20}H_{20}O_2$) in from 3 to 4 times its volume of ordinary spirit of wine, passing hydrochloric acid gas through it, until the liquid becomes brown and fuming, distilling off the volatile portion, and adding water to the residue, an oil is obtained which boils at 230° to 235°; it possesses an agreeable odour of fruit, and solidifies after some time into a mass of crystals, which fuse at 13°, and have, likewise, the composition $C_{20}H_{20}O_2$; these crystals are readily dissolved by cold concentrated sulphuric acid, the liquid becoming only slightly coloured; on heating this solution, it yields a conjugated acid, whose baryta-salt is soluble in water. Ordinary rue-oil does not exhibit this comportment.

Gerhardt has pointed out that rue-oil has the composition of the aldehyde of capric acid; a boiling aqueous solution of nitrate of protoxide of silver scarcely acts upon it; on ebullition, however, with ammoniacal silver-solution, the silver is reduced. On heating 1 part of oil with 1 part of ordinary nitric acid, diluted with an equal volume of water, a violent reaction takes place, which continues for a considerable time; if, the action having ceased, the mass be boiled until red vapours are no longer evolved, addition of potassa separates a certain quantity of a neutral oil of a very pungent odour; the alkaline solution, when treated with sulphuric acid, yields an oily acid, which may be purified by rectification. It was found to be pelargonic acid, $C_{18}H_{18}O_4$, by the analysis of the baryta- and silver-salts ($MO, C_{18}H_{17}O_3$). The alcoholic solution of the ammonia-salt yields, with an aqueous solution of nitrate of protoxide of copper, a bluish-green precipitate, from whose solution in boiling alcohol, green oily drops are separated on evaporation, which crystallize on cooling, and consist of pelargonate of protoxide of copper; when dried at 100°, they contain $CuO, C_{18}H_{17}O_3$. In the preparation of the baryta-salt from the acid, in addition to pelargonate of baryta, another salt is frequently obtained, which is less soluble in alcohol, and crystallizes after the former. It was found to be caprate of baryta. Gerhardt considers capric and Cahours' rutic acid to be identical (both are $C_{20}H_{20}O_4$). —Cahours(1) claims the priority of several of the statements made by Gerhardt with reference to rue-oil, claims which have subsequently been acknowledged by Gerhardt(2). Incidentally to this reclamation, Cahours farther communicates that he also has

(1) Compt. Rend. XXVI, 362.
(2) Ibid. 361.

found, that according to the duration of the action of nitric acid upon rue-oil, various acids are formed, f.i., the acids $C_{18}H_{18}O_4$ and $C_{16}H_{16}O_4$, and that rutic acid (or capric acid, $C_{20}H_{20}O_4$), when treated with pentachloride of phosphorus yields a volatile liquid, $C_{20}H_{19}ClO_2$, chloride of rutyl, which forms with potassa, chloride of potassium and rutate of potassa. Rue-oil.

Thyme-oil.—Doveri(1) has communicated investigations upon thyme-oil (from *Thymus vulgaris*). The oil examined was reddish-brown, and deposited, after some time, a stearoptene, feebly reddening litmus-paper and possessing a powerful odour, which called to mind that of thyme, when in a state of very great diffusion. When rectified, the oil was of a pale-yellow colour. Rectified thyme-oil commences to boil at 150°, the boiling-point rapidly rising to 175°, where it continues constant for some time; it then slowly rises to 180°, and afterwards quickly to 230°, from which point it only slowly mounts up to 235°.—The composition of that which passed over from 175° to 180° is represented, according to Doveri, by the formula $C_{34}H_{26}O$, but the vapour-density was found to be only = 4·8, while a condensation to 4 vols. being assumed, the calculated number amounts to 8·3; hence he considers this liquid as a mixture (*v. infra*). When saturated with hydrochloric acid gas, the excess being expelled by a current of carbonic acid, it forms a mobile, reddish-brown liquid, which becomes solid at a few degrees below 0°, and again liquifies at the ordinary temperature; this liquid deposited, after long standing, small prismatic crystals, and solidified entirely at −17°; the mass, when spread upon a porous tile, separated into small white crystals, a liquid being absorbed. Anhydrous phosphoric acid does not perceptibly act upon that portion of thyme-oil which distils between 175° and 180°. The portion boiling between 230° and 235° is less mobile than the preceding liquid; its composition is expressed by the formula $C_{20}H_{15}O_2$, with which its vapour-density agrees (experiment, 5·5; theory, a condensation to 4 vols. being assumed, 5·3). Nitric acid violently attacks this liquid, carbonic acid and nitrous vapour being evolved; the residue, washed with a large amount of water, forms a soft, resinous, orange-yellow mass, of a peculiarly offensive odour, which is soluble in alcohol and reprecipitated by water from the solution in yellow flakes; with aqueous solution of the alkalies it forms a reddish-brown, and on agitation, a strongly frothing, liquid. With anhydrous phosphoric acid

(1) Ann. Ch. Phys. [3] XX, 174; J. Pr. Chem. XLI, 318; Ann. Ch. Pharm. LXIV, 374 (in abstr.).

Thyme-oil.

it evolves heat and assumes a wine-red colour and syrupy consistence; it then yields a distillate, which when repeatedly rectified over phosphoric acid, and subsequently with water, appears as a very mobile, colourless liquid of a naphtha-like odour, which boils at 175° and is represented by the formula C_{20} H_{14} O, being consequently derived by the abstraction of 1 eq. of HO from that portion of thyme-oil which distils between 230° and 235°. By repeatedly distilling this liquid over anhydrous phosphoric acid, another eq. of water is withdrawn and a small portion of a carbohydrogen, C_{20} H_{13}, obtained, which appears to boil at 180°. Doveri believes that this carbohydrogen, in a free state, is contained in thyme-oil, and that the portion of thyme-oil, which distils between 175° and 180°, consists of a mixture of this hydrocarbon with one of its hydrates.

Oil from Matricaria Parthenium.—Dessaignes and Chautard(1) have investigated the volatile oil from *Matricaria parthenium*, which was obtained by distilling the upper half of the plant (branches, leaves and flowers). It is of a greenish colour; that which was prepared in the hot and dry summer of 1846, deposited, after twenty-four hours, large crystalline plates of a stearoptene, while that prepared in the summer of 1845 did not exhibit a similar deportment. The stearoptene, when separated and pressed at from 4° to 5°, possesses a strong and pure camphor-odour; it fuses at 175°, and boils constantly at 204°. On analysis, 78·8 per cent of carbon and 10·7 of hydrogen were found; hence it is identical with the camphor of the *Lauraceæ*, whose presence in several volatile oils derived from the family of the *Labiatæ* had already been established by Proust: here then we meet with the same compound in a plant of the syngenesia. The oil, separated from the stearoptene, entered into ebullition at 160°, the boiling-point rising rapidly to 205°; from this point to 220°, the greater part of the oil distilled over, a coloured residue remaining behind. No oil of a constant boiling-point was to be obtained by fractional distillation, the various portions of the distillate depositing stearoptene; in that which passed over between 160° and 168°, 86·5 carbon and 11·6 hydrogen were found; the portion distilling between 210° and 220°, yielded 77·0 carbon and 10·3 hydrogen. Dessaignes and Chautard believe that the oil of *Matricaria parthenium* contains, in addition to the stearoptene, a carbohydrogen C_5 H_8, and an oil richer in oxygen than the stearoptene.

(1) J. Pharm. [3] XIII, 241; J. Pr. Chem. XLV, 45; Ann. Ch. Pharm. LXVIII, 342.

Imperatoria-oil.

Imperatoria-Oil.—Hirzel(1) has investigated imperatoria-oil which is obtained by distilling the powder of master-wort (of *Imperatoria ostruthium*) with water; the dark-brown oil separates upon the surface of the distillate, a small additional portion being abstracted from the lower stratum by agitation with ether. When distilled with water it leaves a tarry residue and yields a colourless distillate, in which (after drying by chloride of calcium) were found 84·8—85·6 per cent of carbon, 11·4 of hydrogen and of 3·0 to 3·8 oxygen. It enters into ebullition at 170°, but the boiling-point continually rises; the distillate collected between 170° and 180°, exhibited nearly the above mentioned composition; on the other hand, that which passed over from 200° to 220°, yielded 81·1 per cent of carbon, 11·7 of hydrogen, and 7·2 of oxygen. By distilling the oil with anhydrous phosphoric acid, a colourless liquid, of a rosemary odour, is obtained, having the composition C_{30} H_{24}, and yielding a compound C_{30} H_{25} Cl, by saturation with hydrochloric acid, distillation of the resulting reddish-yellow liquid with water, and subsequent dessiccation by means of chloride of calcium. The oil forms with chlorine a thick, yellow, oily liquid, with separation of hydrochloric acid.

Valerian-oil.—According to Hurault(2), valerian-oil does not appear to be contained ready formed in the roots of valerian, but is produced only by the action of water; pure ether does not extract any volatile oil from the roots.

Oil from Tropæolum majus.—Cloez(3) (unacquainted, as it appears, with Bernay's(4) observations) has communicated the fact that the oil from *Tropæolum majus* contains sulphur; according to his statements, it is denser than water, and boils at from 120° to 130°.

Oil of Turpentine.—Oil of turpentine and several other volatile oils isomeric with it, deposit under certain circumstances, a crystalline body, to which Blanchet and Sell(5) assign the formula $C_{20}H_{20}O_4$, Dumas(6) the formula C_{20} H_{22} O_6. This compound has been designated as turpentine-camphor or hydrate of turpentine-oil. Wig-

(1) Mittheilungen der Züricher naturforschenden Gesellsch. Nr. 27; J. Pr. Chem. XLVI, 292; Chem. Gaz. 1849, 98.

(2) From the Recueil, &c. (II. 3), Janvier, 1847, 38, in J. Pharm. [3] XII, 69.

(3) Ibid. 36, in J. Pharm. [3] XII, 69.

(4) Repert. Pharm. [2] XXXVIII, 387; Berzelius' Jahresber. XXVI, 670.

(5) Ann. Ch. Pharm. VI, 267; Berzelius' Jahresber. XIV, 301.

(6) Ann. Ch. Phys. [2] LVII, 334; Berzelius' Jahresber. XV, 315.

Oil of turpentine.

gers(1) found that this body is more readily formed when oil of turpentine is allowed to remain in contact with nitric acid and alcohol, and expressed its composition by the formula $C_{20}\,H_{20}\,O_4$. Deville(2) confirmed his statement respecting the mode of formation, but arrived at the formula $C_{20}\,H_{22}\,O_6$. In a subsequent investigation of this body, for which Berzelius proposed the term *terpin*, Wiggers(3) found its composition in the crystalline state to be represented by $C_{20}\,H_{22}\,O_6$, in the dry state by $C_{20}\,H_{20}\,O_4$. List(4) has now undertaken a new investigation of this compound. He prepared it according to Wiggers' direction, confirming his statement, that solar irradiation favours the formation of terpin; the crystals thus obtained, as Rammelsberg(5) had previously found, are rhombic, $\infty P . P . \infty \bar{P} \infty (\infty P : \infty P = 77^0\,4'; P : \infty P = 127^0\,2')$; and contain $C_{20}\,H_{20}\,O_4 + 2\,HO$; they fuse below 100°, 2 HO being evolved. The water separates likewise, over sulphuric acid, at the ordinary temperature. The anhydrous compound $C_{20}\,H_{20}\,O_4$ fuses at 103° and solidifies at 91°, when rapidly cooled and protected from moisture, to an amorphous mass, becoming crystalline again by exposure to the breath or atmospheric moisture (at 36°), and to the vapour of alcohol and ether. The crystallization of terpin is attended by an increase of volume. Terpin, freed from water, sublimes only with the assistance of a current of air or of aqueous vapour. If a small quantity of an acid be mixed with a hot aqueous solution of terpin, the liquid becomes milky, with separation of a compound $C_{20}\,H_{17}\,O$, which Wiggers had previously obtained by heating terpin with concentrated hydriodic acid, and for which List proposes the name *terpinole;* this compound has an agreeable odour, especially when in a state of considerable diffusion; its spec. grav. is 0·852, its boiling-point 168°. List believes that the formation of terpinole depends upon the previous production of a compound of terpinole with the acid, which immediately splits into its constituents. If hydrochloric acid be passed over powdered terpin, the mass is converted, with evolution of heat, into a brownish liquid, from which a crystal-

(1) Ann. Ch. Pharm. XXXIII, 358; Berzelius' Jahresber. XXI, 335.

(2) Instit. 1841, 427; Berzelius' Jahresber. XXII, 293 and Instit. 1843, 89; Berzelius' Jahresber. XXIV, 477.

(3) Ann. Ch. Pharm. LVII, 247; Berzelius' Jahresber. XXVII, 440.

(4) Ueber das so-genanute Terpenthinöl-hydrat. (Inauguraldissertation), Göttingen, 1848; Ann. Ch. Pharm. LXVII, 362 (in abstr.); J. Pr. Chem. XLIII, 499; Instit. 1848, 188; Laurent and Gerhardt's Compt. Rend. des Trav. Chim. 1849, 125; J. Pharm. [3] XV, 317.

(5) Pogg. Ann. LXIII, 570; Berzelius' Jahresber. XXV, 606.

line body soon separates; the same compound is also formed by passing hydrochloric acid into terpinole. Recrystallized from alcohol it forms long, thin, nacreous plates, of the composition C_{20} H_{18} Cl_2, being isomeric with the solid hydrochlorate investigated by Blanchet and Sell(1) and by Dumas(2), but differing from it by its solubility in alcohol and a somewhat higher fusing-point; it fuses at 50° and solidifies at 46°. An iodine-compound, corresponding to the chlorine-body, appears to exist; it could not, however, be prepared in a state of purity. On distillation, the chlorine-compound evolves hydrochloric acid and yields, when repeatedly distilled over caustic lime, a mobile, highly refractive oil, C_{20} H_{16}, possessing a refreshing rosemary-odour. This compound is likewise formed by repeatedly distilling terpin, free from water, with anhydrous phosphoric acid. The chlorine-compound is converted into terpinole when boiled for several days with water, in such a manner that the condensing liquid flows back. Oil of turpentine.

Cailliot(3) has investigated the products of the action of nitric acid upon oil of turpentine. Of these, turpentinic acid, discovered by Bromeis(4) (C_{14} H_{10} O_8), and recently investigated by Rabourdin(5) under the name terebic acid, was previously known. If turpentine-oil be added in small quantities to an excess of nitric acid diluted with an equal weight of water in a distilling apparatus, the action may be easily regulated. Nitrous, carbonic, and hydrocyanic acids are evolved, while unchanged turpentine-oil passes over; the operation is interrupted when the boiling liquid ceases to evolve red vapours; at this point an acid liquid and a resinous substance remain in the retort. By evaporating the acid liquid and treating the residue with water, an orange-coloured, pitchy substance remains behind, containing a resinous compound and two acids.—One of these acids is insoluble in water and in alcohol: it is separated from the resinous compound, which is likewise insoluble in alcohol, by treatment with ammonia. The ammonia-salt obtained is purified by animal charcoal and repeated recrystallization, the acid being finally separated therefrom by means of a mineral acid. It then forms a white, crystalline, tasteless powder, insoluble in water, alcohol, and ether. Cail-

(1) Ann. Ch. Pharm. VI, 285.
(2) Ibid. IX, 56.
(3) Ann. Ch. Phys. [3] XXI, 27; J. Pr. Chem. XLII, 233; Ann. Ch. Pharm. LXIV, 376 (in abstr.); Repert. Pharm. [2] XLVIII, 98.
(4) Ann. Ch. Pharm. XXXVII, 297; Berzelius' Jahresber. XXII, 299.
(5) J. Pharm. [3] VI, 285; Berzelius' Jahresber. XXV, 601.

Oil of turpentine.

liot terms it *terephtalic acid,* and considers its composition to be $C_8 H_3 O_4$, its silver-salt being $AgO, C_8 H_2 O_3$; the phenomena, however, attending the decomposition of this acid, render it probable that it is a bibasic acid, and that it is represented by the formula $C_{16} H_6 O_8 = C_{16} H_4 O_6 + 2 HO$. The acid thus becomes isomeric with phtalic acid, from which it is distinguished, however, by its solubility, and by the fact of its salts being decomposed by phtalic acid. By heating, part of this acid sublimes unchanged, while another portion is decomposed with evolution of carbonic acid, and formation of benzole, with which the sublimed acid is mixed, while a small quantity of carbon remains behind. Nearly all the terephtalates are crystalline; they are exceedingly inflammable, being, when well dried, readily inflamed by a spark, and then burning like tinder with evolution of the odour of benzole.—The acid which together with terephtalic acid is contained in the orange-coloured substance can be readily separated therefrom by boiling water, alcohol or ether; from the hot aqueous solution it separates on cooling in brilliant white needles. Cailliot names this acid *terebenzic acid;* distilled with water it readily passes over with it; he considers its composition to be $C_{14} H_7 O_4$ (in combination with bases $C_{14} H_6 O_3$), according to which it contains 1 equiv. of hydrogen more than benzoic acid; it fuses at 169° (49° higher than benzoic acid); its boiling-point is very high, but in open vessels it sublimes even below 100°; its ether has an odour similar to that of anise, and boils at 130° (benzoic ether at 209°). The terebenzates in general exhibit the same degree of solubility as the corresponding benzoates.—The acid liquid from which the orange-coloured pitchy substance has been separated, when concentrated and allowed to stand, yields, after some time, a copious crystallization of oxalic acid, and subsequently a greyish-white deposit of oxalic and terpentinic acids, (terebic acid), which are mixed with a small quantity of terephtalic acid, and a larger portion of terebenzic acid. The mother-liquor, separated from this deposit, contains small quantities of the same acids, held in solution by nitric, and another acid, communicating the orange colour to the solution, and termed by Cailliot *terechrysic acid.* In order to prepare this acid, the liquid is evaporated to the consistence of a paste, by which means the oxalic acid is destroyed by the nitric acid; some terebenzic acid is then separated by treatment with water, and the liquid neutralized with carbonate of baryta, which throws down terebenzic and terephtalic acid. The baryta-salt thus formed is decomposed by sulphuric acid, when a solution of terechrysic acid is obtained, which is farther

Oil of turpentine.

purified by addition of a boiling solution of acetate of lead; on cooling, terechrysate of protoxide of lead separates in microscopic crystals, which are decomposed by sulphuric acid. The aqueous solution of terechrysic acid leaves, on evaporation, an orange-yellow, pasty, uncrystallizable residue, which tastes at first acid, and subsequently harsh and bitter; it dissolves in all proportions in water, alcohol, and ether; Cailliot adopts for the lead-salt dried at 120° the formula $PbO, C_6 H_3 O_4$. Terechrysic acid is decomposed by heating; its salts are yellow or orange-red, and for the most part soluble in water; its ether is a mucilaginous, dark orange-red liquid, which is likewise decomposed by heat.

The resinous substance (see II. p. 47), which is found in the retort after the action of nitric acid upon oil of turpentine, when only a gentle action has taken place, is reddish-brown, soft at the ordinary temperature, and almost completely soluble in alcohol; but when the action has been continued for a longer time it is yellow, friable at ordinary temperatures, and only partially soluble in boiling alcohol. The insoluble portion is terephtalic acid. From the residue of the evaporated alcoholic solution, water extracts terebenzic acid; what then remains is a mixture of three non-nitrogenous resins. To the one which is insoluble in cold, and slightly soluble in boiling alcohol, Cailliot assigns the formula $C_{40} H_{24} O_{20}$; it is precipitated from the latter solution as a yellow non-crystalline powder, which is insoluble in aqueous ammonia and potassa, and fuses only above 100°. Both the others are soluble in cold alcohol; the one, which is insoluble in ammonia and potassa-solution, and fuses below 100°, he represents by the formula $C_{40} H_{24} O_{10}$, and the other (soluble in ammonia and potassa-solution and becoming semi-liquid at 100°) by the formula $C_{40} H_{24} O_{16}$.

Fermentolea.—Becker of Mühlhausen(1) has expressed the opinion that *fermentolea* were well known to the old alchemists, being in fact what they used to designate by the term quintessence. —According to Artus(2) "the formation of *fermentolea* is due to the tendency exhibited by the elements, to acquire a higher state of organic unity in the production of cryptogamia and infusoria, whereby much nitrogen is consumed, which is separated and fixed at the expense of the organic formations just mentioned. Hence the liberation of carbon, hydrogen, and oxygen, which, meeting in *statu nascenti*, enter into chemical unity, and thus give rise to the formation

(1) Arch. Pharm. [2] LV, 161.

(2) Jahrb. Pr. Pharm. XV, 25.

Fermentolea.

of the *fermentolea.*"(!) Bley(1) obtained, by fermenting 150 lbs. of meadow-sage (*Salvia pratensis*) with water, distilling, and returning the distillate, 70 grains of a dark reddish-brown *fermentoleum,* of sweetish ethereal, disagreeable odour, and aromatic taste, dissolving in all proportions in alcohol and ether, slightly soluble in water, almost insoluble in potassa-solution, readily miscible with the fatty oils, and forming a liniment with ammonia.—Berzelius(2) has enumerated the hitherto known *fermentolea;* such products have been obtained from *Gentiana centaureum,* oak-leaves, almond-syrup, *Achillea millefolium, Echium vulgare, Urtica urens, Salix pentandra,* various species of *Plantago, Chelidonium majus, Conium maculatum,* from fermenting potatoes, grapes, and corn. All the fermentolea are more soluble in water than the ordinary volatile oils; from their analogy to fusel-oil Berzelius considers it probable that they are alcoholic bodies.

Furfurole.—Some new statements have been made by Fownes(3) respecting the volatile oil formerly(4) prepared by him from bran by means of sulphuric acid, and investigated under the name of furfurole. This oil, as is well known, was originally obtained by Döbereiner in the artificial preparation of formic acid, and hence the term artificial ant-oil, assigned to it; subsequently the same body, prepared by the action of dilute sulphuric acid upon wheat-flour or sawdust, had been analysed by Stenhouse(5), who found its composition to be $C_5 H_2 O_2$.—On distilling 64 oz. (troy-weight) of wheaten bran with 32 oz. of sulphuric acid, and an equal volume of water, Fownes obtained nearly 1 oz. of furfurole; while 64 oz. of wheaten flour, when distilled with 32 oz. of sulphuric acid and an equal volume of water, yielded only about $1\frac{1}{2}$ drachm of impure furfurole; about 4 lbs. of starch, with 2 lbs. of sulphuric acid, and an equal volume of water, gave only indefinite traces; while on distilling, 2 lbs. of recently washed linen, with 1 lb. of sulphuric acid, and an equal volume of water, not the slightest trace of furfurole was obtained. The amount of furfurole obtained, increased in the same proportion as the bran contained less starch, gluten, &c. Fownes is inclined to the opinion, that it is the substance designated by Payen as *matière incrustante,* which gives rise to the formation of furfurole. He

(1) Arch. Pharm. [2] LI, 257.
(2) Berzelius' Jahresber. XXVII, 541.
(3) Pharm. J. Trans. VIII, 113.
(4) Ann. Ch. Pharm. LIV, 52; Berzelius' Jahresber. XXVI, 582.
(5) Ann. Ch. Pharm. XXXV, 301; Berzelius' Jahresber. XXI, 328.

enlarges his earlier statements regarding this body by the following remarks. When freshly distilled, furfurole is colourless, but even in the dark it becomes rapidly yellow; when exposed to light for a few hours it assumes a brown colour; in contact with water this colouration takes place more slowly. The spec. grav. is 1·1648 at 15°·6, in contact with metal its boiling-point is from 162°·8 to 163°·3 at 29·9 inches (Engl.) atmospheric pressure; in each distillation it partially blackens, and is slightly decomposed. At 15°·6 it dissolves in 12 times its weight of water, at higher temperatures in less. Its vapour-density was found to be 3·49; a condensation of $C_5 H_2 O_2$ to 2 vols., or of $C_{10} H_4 O_4$ to 4 vols., being assumed, the calculated density is 3·34. Furfurole.

Cahours(1) likewise has communicated investigations upon furfurole. From 1·5 kilogr. of bran, and 1·25 kilogr. of sulphuric acid previously diluted with 3 litres of water, he obtained, on the average, a quantity of furfurole amounting to 2·63 per cent of the weight of the bran employed; by using somewhat less sulphuric acid, from 2·5 to 2·6 per cent. Bran, when distilled with water alone does not yield any oil, which must be formed from some constituent other than woody-fibre, starch, or gluten, for neither of these bodies when distilled with sulphuric acid, yields the slightest trace of furfurole.—For this substance Cahours found the boiling-point 162°, and the vapour-density 4·34. Chlorine and bromine give with furfurole black, resinous products; nitric acid in every degree of dilution finally produces oxalic acid; sulphuric acid and binoxide of manganese, and also chromic acid, converts it into a brown substance. The statements made by Fownes with reference to furfuramide and furfurine have been confirmed by Cahours.—By rapidly passing a current of hydrosulphuric acid into a concentrated alcoholic solution of furfurole a resinous precipitate of *thiofurfole* is obtained; by passing the gas slowly into a dilute solution, the same body precipitates as a white, crystalline powder of the composition $C_{10} H_4 S_2 O_2$, being furfurole, in which half the oxygen is replaced by sulphur. Thiofurfole is likewise formed by the action of sulphide of ammonium upon a solution of furfurole; it fuses on heating, with evolution of a strong and unpleasant odour; when more strongly heated it burns with a bluish, and almost sootless flame. Thiofurfole is decomposed on distillation with formation of a yellow crystalline substance free from

(1) Ann. Ch. Phys. [3] XXIV, 277; J. Pharm. [3] XV, 170; Ann. Ch. Pharm. LXIX, 82; J. Pr. Chem. XLVI, 45.

Furfurole. sulphur, which recrystallized from alcohol, is obtained in the form of long, colourless, or slightly yellow needles, of the lustre of diamonds; they are insoluble in cold, slightly soluble in hot water, in alcohol, and in ether; their composition is $C_{18} H_8 O_4$; their alcoholic solution when exposed to the air becomes brown, and is slowly decomposed. (In reference to the formation of this compound, Cahours believes, that the formula assigned to thiofurfole has at least to be doubled). By a process similar to that for thiofurfole, *seleniofurfole* $C_{10} H_4 Se_2 O_2$ was prepared in the form of a resinous, unstable substance.

Respecting œnanthole, see I. 434.

Mesitilole.—Cahours(1) finds that, mesitilole yields, with fuming nitric acid a brownish-red, heavy oil, of a powerful odour, which does not appear, however, to be a definite compound. On the other hand, if mesitilole be added, drop by drop, to a mixture of fuming sulphuric and nitric acids, the liquid being continually stirred, a white flaky body is rapidly separated, which after drying, forms an aggregate of delicate, felted needles. By diluting the liquid with water, washing and drying, this compound may be obtained in a state of purity; its formula is $C_6 H_3 N O_4$; when gently heated it sublimes without decomposition.

Camphor.—Bineau(2) has communicated observations respecting the deportment of camphor with several acids.—Camphor rapidly absorbs sulphurous acid, and yields a colourless liquid, heavier than water, dissolving iodine abundantly, and from which, on exposure to the air, the sulphurous acid is readily evolved, unchanged camphor being left behind. The proportions of combination are very variable, as exhibited in the following synopsis, in which A represents the temperature, B the pressure, and C the quantity of acid taken up by 100 parts of camphor:

A.	24°·0	24°·0	24°·0	21°·0	20°·0	15°·5	15°·5	14°·0	14°·0	12°·5	12°·5
B.	524mm	650mm	745mm	670mm	730mm	355mm	744mm	611mm	738mm	529mm	703mm
C.	25·5	30·8	35·4	34·7	39·7	28·0	47·6	40·4	48·6	37·3	49·1

A.	12°·5	10°·0	10°·0	10°·0	8°·0	8°·0	8°·0	4°·0	4°·0	2°·0	2°·0
B.	727mm	320mm	560mm	720mm	304mm	503mm	682mm	490mm	720mm	469mm	650mm
C.	50·5	31·7	42·6	55·8	33·0	42·0	57·4	46·0	73·6	48·4	72·0

Hence it follows, that under a pressure of 700mm the proportions are approximately:

A.	24°·0	20°·0	15°·5	14°·0	12°.5	10°·0	8°·0	4°·0
C.	33·1	37·7	44·3	46·8	48·9	54·0	58·6	70·5

(1) Loc. Cit. I, 295.

(2) Ann. Ch. Phys. [3] XXIV, 326; J. Pr. Chem. XLVI, 296.

Camphor undergoes no alteration in an atmosphere of binoxide of nitrogen, but if oxygen be admitted it forms the same liquid that is produced by direct treatment of camphor with hyponitric acid; this liquid is slightly yellow; it evolves reddish vapours in dry air, until it becomes covered with a pellicle of camphor, and it yields, with water, the decomposition-products of hyponitric acid, and a precipitate of camphor; the compound, saturated with camphor, contains, at 18°, 21 acid to 79 camphor. This compound, when exposed to the action of sulphurous acid, absorbs this gas, with the evolution of red vapours, and the gradual separation of a white, crystalline compound, which, when left for some time, likewise evolves red vapours; for the composition of this body very variable results were obtained.—The compound also of camphor with hydrochloric acid, Bineau found of very variable composition, as is seen from the following table; A, B, and C, having the same signification as above: Camphor.

A.	24°·0	20°·0	18°·5	18°·5	13°·0	9°·0	7°·0	7°·0	3°·0	3°·0
B.	747mm	740mm	735mm	744mm	320mm	288mm	270mm	740mm	232mm	738mm
C.	19 ·0	20 ·0	20 ·4	20 ·5	15 ·3	15 ·8	16 ·3	24 ·0	17 ·0	26 ·0

Camphor ceases to absorb hydrochloric acid:

Under a pressure of . .	22	34	39	42	centimetres.
At a temperature of . .	12°	15°	20°	24°	

Terfluoride of silicium, and hydrosulphuric acid, are without action upon camphor at the ordinary temperature. The vapour of anhydrous sulphuric acid, when slowly acting upon camphor at a very low temperature, converts it (almost without evolution of gas) into a white, or slightly brown mass, from which water separates the greater part of the camphor without any change.

Hesperidin.—Ricker(1) has described a substance as hesperidin, which had been deposited from fresh bergamot-oil, after standing for some time; by this name, as Berzelius(2) has previously remarked, various substances appear to have been designated. Ohme(3) declares the substance described by Ricker, and the bodies generally designated hesperidin, to be ordinary stearoptenes(4).

Solid Carbohydrogen from Amber.—According to Reich(1), if a mixture of prepared amber-powder, and highly concentrated potassa-

(1) Jahrb. Pr. Pharm. XIV, 326.
(2) Berzelius' Jahresber. XXII, 452.
(3) Arch. Pharm. [2] LIII, 287.
(4) For the hesperidin which crystallizes from an aqueous solution, this opinion cannot be received.
(5) Arch. Pharm. [2] LI, 26.

Solid carbohydrogen from amber.

solution, be heated to ebullition, and subsequently distilled to dryness, a very strong odour of camphor becomes perceptible, while a white substance, possessing the properties of camphor, collects in the receiver, together with the aqueous liquid; this compound differs from the amber-camphor obtained by Vogel(1), in the dry distillation of amber.—A body differing from the latter has been obtained also by Bley and Diesel(2), by rapidly distilling amber at a high temperature. This body deposited, together with the succinic acid, in the neck of the retort, as a yellow waxy mass, and was purified by fusion with water, and solution in absolute alcohol; it was lighter than water, of soft consistence, tasteless, and inodorous; it fused at from 85° to 86°, and boiled a little above 300°; it was insoluble in water, readily soluble in spirits of wine, ether, fatty and volatile oils. On analysis, 86·1 per cent of carbon, and 13·7 of hydrogen was obtained, closely agreeing with the formula C H, and the composition of ozokerite, which it resembles in many respects.

Tolu-Balsam.—Tolu-balsam, which had been formerly investigated by Fremy(3) and by Deville(4), has been recently examined by E. Kopp(5). The latter chemist found in this balsam a very minute quantity of tolene ($C_{10}H_8$), free cinnamic acid ($C_{18}H_8O_4$), a resin, readily soluble in alcohol ($C_{36}H_{19}O_8$), and another resin difficultly soluble ($C_{36}H_{20}O_{10}$); he considers the former resin as the chief constituent of tolu-balsam, and from which the other resin and cinnamic acid are formed by the action of air.—He found the boiling-point of the tolene, prepared according to Deville's method, to be between 154° and 160°, and the spec. grav. 0·858 at 10°; he believes that its formula is more probably $C_{10}H_8$, than $C_{12}H_9$, which is the expression adopted by Deville; when kept in open vessels, it is converted into a resin.—Kopp confirms the statement, that cinnamic acid, but no benzoic acid, is contained in tolu-balsam; the fact that Deville and others have found benzoic acid therein, he explains from a change which the resin in the balsam may have undergone during distillation, or by the treatment with concentrated potassa-solution. He observes, that cinnamic acid, when mixed with concentrated caustic soda-solution, and treated with chlorine, is

(1) Gehlen's Neues Allgemeines Journal der Chemie (1805) V, 272.
(2) Arch. Pharm. [2] LV, 171.
(3) Ann. Ch. Phys. [2] LX, 180; Berzelius' Jahresber. XX, 396.
(4) Ann. Ch. Phys. [3] III, 151; Berzelius' Jahresber. XXII, 349.
(5) Ann. Ch. Phys. [3] XX, 379; Compt. Rend. XXIV, 614; J. Pharm. [3] XI, 425; Ann. Ch. Pharm. LXIV, 372; J. Pr. Chem. XLI, 326; Laurent and Gerhardt's Compt. Rend. des Trav. Chim. 1849, 145 (in detail).

converted into chlorocinnamic acid ($C_{18} H_7 Cl O_4$); and that, by the action of concentrated nitric acid it is converted, at first, into nitrocinnamic, then into benzoic acid, and subsequently into nitrobenzoic acid. He prepared nitrobenzoate of oxide of ethyl, $C_4 H_5 O$, $C_{14} H_4 (NO_4) O_3$, (by the action of hydrochloric acid upon an alcoholic solution of the acid), and found it to be a white, colourless compound, of an aromatic odour and taste, which crystallizes in foliated crystals, belonging to the rhombic system; it fuses at 47°, and boils at 296°. On heating an alcoholic solution of nitrocinnamic acid with sulphide of ammonium sulphur is deposited, with formation of a yellow resin, and a solid and colourless organic base, which crystallizes in warty grains; it is soluble in alcohol and ether, and forms salts, which are difficultly crystallizable.—The resin ($C_{36} H_{19} O_8$) is readily soluble both in alcohol and in ether, it is a brown, brilliant translucent substance, brittle in the cold; its powder cakes together at as low a temperature as 15°, and fuses at 60°; concentrated sulphuric acid colours it purple-red; when dissolved in caustic potassa it is readily oxidized in the air, and passes into the following resin. When subjected to dry distillation it yields, with evolution of gas, an oily liquid, which is split by the action of concentrated potassa-solution into benzoin, benzoic acid, and another transparent, neutral oil, boiling above 250°.—The resin ($C_{36} H_{20} O_{10}$), insoluble in alcohol and in ether, is brownish-yellow, inodorous and tasteless; it fuses only above 100°; it is soluble in sulphuric acid, with a reddish-brown colour, (turning violet-red if the solution be exposed to moist air), and in caustic potassa-solution with a brown coloration.—If 1 part of the resinous constituent of tolu-balsam, as it remains after treatment with soda-solution, be heated with 4 parts of ordinary nitric acid, a violent reaction takes place, bitter almond-oil, hydrocyanic acid, and some benzoic acid passing over; in the retort, there remains, in addition to a resin and reddish-yellow liquid, a yellow flaky mass, which is benzoic acid, to which a yellow colouring matter pertinaciously adheres, preventing its crystallization; this substance remains behind on application of heat, while benzoic acid sublimes.

Tolu-balsam.

Resins in General.—Heldt(1) has communicated some considerations respecting the origin of resins in general, among which he classes various substances, such as santonin, asarone, helenin, cubebin, athamantin, &c., which are usually distinguished from the resins. He derives their formation from the ethereal oils, which, according to his views, are either $C_{10} H_8$, or hydrates, or oxides of this carbo-

(1) Ann. Ch. Pharm. LXIII, 48.

Resins in general.

hydrogen. The atomic composition of various resins, or of substances which he considers as such, when reduced to the same amount of carbon—namely, to 120 C, may be represented by the formula $C_{120}H_{96}$, wherein more or less hydrogen may be replaced by oxygen; the ethereal oils, whose composition is expressed by $C_{10}H_8$, or by a multiple of this formula, may differ in the way in which their elements are grouped, according to the quantity of hydrogen they contain, which is replaceable by oxygen. With regard to a large number of resins, he discusses in detail the constituents from which they are derived, and in which manner their formation may take place. We cannot here enter into the details of this discussion, but only give the general results as adduced by Heldt.—1. A series of resins are formed by the elimination of a certain number of hydrogen-equivalents in the form of water, from the correlative oil, and their replacement by an equivalent proportion of oxygen; they are substitution-products. (Epsilon copal-resin, resin of *Ceradia furcata*, helenin, alpha-resin of styrax benzoin, santonin, eugenin, gamboge-resin, cubebin, phlobaphin, anemonin, asarone, soft resin of myrrh, chrysophanic acid). Some of the resins which are thus formed combine with bases, while others do not, and all dissolve in water.—2. A second class of resins is formed, according to the first rule, with simultaneous assumption of the elements of water; they may be considered as hydrates of substitution-products. (Styracin, readily soluble euphorbium-resin, anime, erythroretin, [red resin of rhubarb], mastich, amber, pasto-resin, cerin, lactucone, caryophyllin, elemi-resin, cow-tree-resin, aloëtin). These resins are generally of an indifferent character, and soluble in alcohol and ether.—3. A third class arises from the ethereal oils, according to the first rule, with assumption of an additional quantity of oxygen; they may be considered as oxides of substitution-products. (Copaiba-balsam, sylvic acid, pimaric acid, the resins of *Pinus abies*, investigated by Johnston, oxysylvic acid, betulin, birch-bark-resin, plantain-resin, parietin, athamantin, difficultly soluble euphorbium-resin, myrrhin, alpha-, beta-, and gamma-resin of copal, Dammar-resin). They generally combine with bases without water being separated from the composition; their solubility in alcohol and ether increases with the augmentation of oxygen, while their fusing-points, on the contrary, decrease in the same proportion.—4. A fourth class of resins originate, according to the third rule, with simultaneous assimilation of water; they may be considered as hydrated oxides of substitution-products. (The remaining resins of the coniferæ, phæoretin [brown resin of rhubarb], aporetin, jalap-resin). The

Resins in general.

water assumed by these resins is not separated in their combination with bases.—5. Lastly, resins are formed by the assumption of water into the constitution of ethereal oils. (Soft resin of elemi, peru-balsam, brean, and icican).—The artificial imitation of resins from ethereal oils by the oxygen of atmospheric air, nitric acid, or chromic acid, could not be accomplished.

Dammar-Resin. — Dammar-resin, recently investigated by R. D. Thompson(1) has been subjected to a new investigation by A. B. Dulk(2). According to the former, it consists of two resins, dammaric acid, HO, $C_{40} H_{30} O_7$, and dammaran, $C_{40} H_{31} O_6$, the resin itself having the composition of the latter constituent. Dulk makes the following statements. The resin commences to fuse at 73°; it is difficult of combustion, and leaves 0·215 per cent of ash, which contains traces of iron, lime, and especially potassa, together with sulphuric acid. Alcohol and ether dissolves the resin only partially, and with decomposition; it is completely dissolved by fatty and ethereal oils, as well as by sulphuric acid; the latter solution assumes a yellow, purple-red, and finally, almost black colour; from this solution (heat having been avoided) the resin is reprecipitated of a whitish-yellow colour on addition of water, but appears to have undergone some change, inasmuch as, on washing it becomes greenish, and softens only at 84°, complete fusion ensuing only at 100°. Acetic and hydrochloric acids, potassa- and ammonia-solution are almost without action upon it; nitric acid dissolves it with decomposition; by heating the finely powdered resin with chlorate of potassa, hydrochloric acid and water, it is converted into a whitish-yellow froth, which, when dried over sulphuric acid, contains about 26 per cent of chlorine. On distilling the resin with soda-lime between 120° and 320° hydrogen is first evolved, and subsequently various hydrocarbons. Analysis of the resin itself gave 82·4 to 82·7 per cent of carbon, 11·2 to 11·3 per cent of hydrogen, and 6·0 to 6·3 of oxygen.—According to Dulk, the resin contains a carbohydrogen (dammaryl), an acid, and probably also a hydrate of this compound. Alcohol and ether, which separate these constituents, at the same time partially decompose them. By the following consecutive treatment of the resin, weak alcohol dissolved 36 per cent (*hydrate of dammarylic acid*), absolute alcohol 43 per cent (*dammarylic acid*), ether 13 per cent (*dammaryl*), 8 per cent remained undissolved.

(1) Ann. Ch. Pharm. XLVIII, 351; Berzelius' Jahresber. XXIV, 490.

(2) Dissertatio de Resinis, præsertim de Resina Dammaræ. Vratislaviæ, 1846; J. Pr. Chem. XLV, 16.

Dammar-resin.

Dulk assigns to the hydrated dammarylic acid the formula HO, C_{45} H_{36} O_3; it is soft when in the form of powder, very electric, and fuses at 56°; its alcoholic solution reddens litmus very feebly. Dulk attributes to anhydrous dammarylic acid the formula C_{45} H_{36} $O_3 = \overline{D}a$; it fuses at 60°, and reddens litmus more strongly. He describes various salts to which he assigns the formulæ KO, Da_2; KO, HO, Da_3; AgO, Da_2; AgO, HO, Da_3; AgO, 2 HO Da_4. —Dammaryl is described as a white, amorphous powder, softening at 145°, fusing at 190°, and having the composition C_{45} H_{36}; when exposed for a long time to the action of steam at 110°, it is converted into a resin of the composition of natural dammar-resin.—The residue, remaining after exhaustion with ether by the above mentioned treatment, is considered by Dulk as a hydrate of dammaryl, 2 C_{45} H_{36} + HO.

For acids of pine-resin we refer to I. p. 440.

Guaiacum-Resin.—Schönbein(1) has made some experiments upon the property exhibited by guaiacum-resin and its spirituous tincture, of assuming under certain circumstances, a blue colour. Ordinary free oxygen does not effect the blue coloration, but it is produced by chlorine, bromine, iodine, ozone, the peroxides of manganese, of lead, and of silver, teroxide of gold, protoxide of silver, protoxide of mercury, permanganic acid, chromic acid, nitrous acid, alkaline hypochlorites, finely divided platinum, chlorides of iron and copper, ferricyanide of potassium, and by fresh potatoes (especially by the eyes or buds). The blue coloration is destroyed by phosphorus, finely divided tin, iron, zinc, and other metals, hydrosulphuric, hydroselenic, and sulphurous acids, salts of protoxides of iron and of zinc, ferrocyanide of potassium, phosphoric, sulphuric, nitric hydrochloric acid and the alkalies; and lastly the blue colouration disappears spontaneously, but with various degrees of rapidity, according to the manner in which it has been produced. By frequently effecting the blue coloration, and again destroying it, as also by the action of atmospheric air, both guaiacum-resin, and its tincture may be deprived of the property of becoming blue.—Riegel(2) has also communicated observations upon the blue colouration of guaiacum-resin.

The falsification of jalap, and scammony with guaiacum-resin, may be detected, according to Smedt and Boudet(3), by addition of hypochlorite of soda to their alcoholic solutions, when a green

(1) Pogg. Ann. LXXIII, 489; LXXV, 351, 357.
(2) Jahrb. Pr. Pharm. XIV, 252. (3) J. Chim. Med. [3] III, 65.

compound is formed which sinks to the bottom; the adulteration of jalap with guaiacum-resin, according to Pasquier-Nalinne(1) may likewise be detected by bringing it into contact with bichloride of mercury and almond-soap, when a deep blue colouration is produced if the resin be sophisticated. Guaiacum-resin.

Caoutchouc.—By various methods introduced within the last few years, we are enabled to communicate to caoutchouc the property of remaining elastic and pliable at all temperatures, consequently also in the cold. This discovery, as is well known, is due to Hancock, who found, that caoutchouc, when immersed at certain temperatures, in a bath of fused sulphur, absorbed a considerable quantity, and became of a blackish colour, acquiring finally the consistence of horn.—The same condition in any desired degree is also attained, if caoutchouc be mixed with sulphur, and exposed to a temperature of 85°, or if it be dissolved in turpentine which is saturated with sulphur, &c. The substance, termed in this country "vulcanized rubber" remains soft and pliable at all temperatures, while ordinary caoutchouc becomes hard before it is cooled down to 0°; it is not attacked by the known solvents of caoutchouc (bisulphide of carbon, petroleum, turpentine-oil), and withstands compression in a high degree.

The method of Parkes(2) consists in immersing leaves of caoutchouc in a mixture of 40 parts of bisulphide of carbon, and 1 part chloride of sulphur. Thick masses cannot be converted in this manner.

Moulton(3) mixes caoutchouc with hyposulphite of lead (obtained by decomposing a lead-salt with hyposulphite of lime), or artificial protosulphide of lead, and heats to 106°—150°.

A patent has been taken out by Westhead(4) for employing sulphurous acid gas (?) for a similar purpose.

Gutta-Percha.—The substance which has become known under the name of *gutta-percha* has been more minutely examined by Soubeiran and by Kent. Soubeiran(5) submitted a portion to experiment which had been imported from China, and was transmitted to him from the Ministry of Commerce in Paris. It was in

(1) J. Chim. Méd. [3] III, 551.
(2) Report. of P. Inv. 1847, 46; Dingl. Pol. J. CIV, 455.
(3) London J. of Arts, 1847, 123; Dingl. Pol. J. CVII, 169.
(4) Ibid. 1848, 347; Dingl. Pol. J. CIX, 47.
(5) J. Pharm. [3] XI, 17; Dingl. Pol. J. CIII, 415.—Upon the source and produce of gutta-percha compare the same, also J. Pharm. [3] XIII, 35; upon the mechanical working of it compare Dingl. Pol. J. CVII, 25, 458; CIX, 118.

Gutta-Percha.

the form of round, somewhat flattened loaves, composed of tough membranous layers of superimposed leaves, and possessing at once the odour of old cheese and of leather. They consisted of pure gutta-percha, a vegetal acid, caseïn, a resin soluble in alcohol, and lastly, of some extractive matter. Gutta-percha, when treated with alcohol and ether, dissolved in turpentine-oil, precipitated and washed with alcohol, and dried at 100°, gave on analysis 83·5 per cent of carbon, and 11·5 of hydrogen. Soubeiran believes the composition of perfectly pure gutta-percha to be C_{12} H_{10} corresponding to 87·8 carbon and 12·2 hydrogen. Faraday found in caoutchouc 87·2 carbon and 12·8 hydrogen. Hence gutta-percha would be of the same composition as caoutchouc, from which it differs, however, essentially in its physical properties, particularly by the absence of great elasticity, and by the peculiarity of becoming plastic at 100° and solid again at the ordinary temperature.

According to E. N. Kent(1) gutta-percha dissolves in turpentine-oil, resin-, gutta-percha-, and tar-oil, terebene and hydrochlorate of terebene. On precipitating or evaporating these solutions, invariably a certain quantity of the hydrocarbon remains behind with the gutta-percha, which does not admit of separation. Gutta-percha dissolves, moreover, in pure chloroform and bisulphide of carbon, from which it may be precipitated unchanged by alcohol; it likewise dissolves, but only slightly, in pure ether.—The solutions in general are brown and do not become clear even after months' standing; solutions of gutta-percha in 16 parts of solvent, may be rendered transparent, but only very slowly, by filtration; the insoluble substances which are suspended, consist of a red colouring matter, soluble in water and precipitable by alcohol, earthy matter, chips and fibres of wood, &c.

If a solution of gutta-percha in chloroform be mixed with 3 parts of ether and exposed for some time to a temperature below 15°, the gutta-percha is precipitated as a white powder, forming, when washed and dried, a soft white mass. On spreading this solution on a plate of glass, a skin is formed, resembling kid-glove leather, which becomes transparent on application of heat.

Crude gutta-percha contains a yellow resin, soluble in alcohol, ether, and oil of turpentine. It is very electrical(2).

(1) Sill. Amm. J. [3] VI, 246.—On a new kind of gutta-percha from the Dutch East Indies, comp. J. Pr. Chem. XLV, 460.

(2) An observation, which has been confirmed particularly by Marchand (J. Pr. Chem. XLIII, 301 ; comp. also I, 205).

Colouring matters.

Colouring Matters.—Preisser(1) published some statements in 1843, according to which he had succeeded in obtaining pure, colourless, and crystalline, the colouring principles of a number of organic substances, by precipitating the alcoholic or ethereal extract of the colouring matter with a substance considered by him to be hydrate of protoxide of lead, by decomposing the resulting lead-compound by hydrosulphuric acid, and evaporating the filtered solution, with exclusion of the air. He proposed the view that all the various colours found in organic colouring materials were only different degrees of oxidation of one and the same colourless substance.—Later experiments have not confirmed any of his statements. Arppe(2) has shown that the precipitant, considered by Preisser to be hydrate of protoxide of lead, and which the latter prepared by decomposing nitrate of protoxide of lead with ammonia, is a basic nitrate of protoxide of lead, the acid of which, when liberated by hydrosulphuric acid, must certainly produce results, f. i., with the colouring matter of cochineal, differing from those which Preisser has stated to have obtained. The statements of Preisser have been, moreover, refuted by De La Rue's experiments, (*vide infra*). Elsner(3) likewise has observed that various red and yellow vegetal colouring matters exhibit a behaviour differing from that which was assigned to them by Preisser; Schlieper(4) found the statements of Preisser respecting the red colouring matter of safflower (carthamin), and Schiel(5) those respecting the colouring-substances of madder, to be in no way confirmed; and Bolley(6), in investigating the colouring principles of sappan-wood, sandal-wood, alkanet, dragon's-blood and quercitron-bark, found Preisser's assertions to be quite incorrect, and has consequently refuted them, together with the conclusions deduced by this chemist.

Colouring matter of Anchusa Tinctoria.—The colouring matter of *Anchusa tinctoria* (the spurious alkanet-root), which was formerly examined by Pelletier(7) and by John(8), and the solutions of which were known to be altered by boiling, has been submitted to a

(1) Dissertation sur l'Origine et la Nature des Matières Colorantes Organiques, &c. Rouen, 1843; Berzelius' Jahresber. XXIV, 508.
(2) Ann. Ch. Pharm. LV, 101; Berzelius' Jahresber. XXVI, 684.
(3) J. Pr. Chem. XXXV, 377; Berzelius' Jahresber. XXVI, 685.
(4) Ann. Ch. Pharm. LVIII, 369; Berzelius' Jahresber. XXVII, 471.
(5) Ibid. LX, 76.
(6) Ibid. LXII, 129; J. Pr. Chem. XLIII, 507, (in abstr.).
(7) Journ. de Physique, LXXIX, 278.
(8) Chemische Schriften, IV, 81.

Colouring matter of Anchusa tinctoria.

new investigation by Bolley and R. Wydler(1). The roots were cut up and exhausted with water; they yielded, at first, a brown, and after some time, a yellow extract, of bitter taste and of acid reaction, and which exhibited, in an undecided manner, the reactions of tannic acid; it left, on evaporation, a brown substance of a taste similar to that of tannic acid (*vide infra*). The roots were dried, after this treatment, and then exhausted with alcohol; on heating the resulting extract to ebullition, its red colour changed to a dingy violet, and afterwards to a greyish-green; after addition of some hydrochloric acid, which prevented this change of colour, the principal portion of the alcohol was distilled off and the colouring matter extracted with ether from the residuary concentrated solution, and from the sediment that had deposited; the ethereal solution, after being washed with water, yielded, on evaporation, a dark-red, resinous, brittle mass. The alcoholic solution of this mass was coloured blue by the alkalies, and precipitated in red flakes by acids, and of a violet colour by an alcoholic solution of bichloride of tin; it yielded no precipitate with an alcoholic solution of acetate of protoxide of lead, but a greyish-blue one, with an alcoholic solution of the basic acetate. According to Bolley and Wydler, this colouring principle is not possessed of acid properties; they therefore propose for it the name *anchusin* or *alkanet-red*, instead of that of anchusic acid, assigned to it by Pelletier; they found it to agree in composition with the formula $C_{35}\,H_{20}\,O_8$ (which requires nearly the same percentage-composition as the formula $C_{17}\,H_{10}\,O_4$, proposed by Pelletier); the amount of protoxide of lead in the lead-compounds obtained, oscillated between 50 and 77 per cent.—On evaporating the above alcoholic extract at the boiling temperature, a blackish-green residue was obtained, which was partly soluble in water, imparting to it an intensely brown colour; ether dissolved much of the insoluble portion, yielding a green solution, which left, on evaporation, *alkanet-green*, a substance not very soluble in alcohol, the composition of which was found to be expressed by the formula $C_{34}\,H_{22}\,O_8$; thus, alkanet-red appears to change to alkanet-green, by the assimilation of 2 HO and the elimination of CO_2 (Bolley and Wydler ascertained by experiment the latter fact).—The wash-water, containing hydrochloric acid, obtained in the purification of the ethereal solution of alkanet-red, yielded on evaporation, a reddish-brown residue, which contained chloride of ammonium; the

(1) Ann. Ch. Pharm. LXII, 141; J. Pr. Chem. XLIII, 509; J. Pharm. [3] XIII, 452, in the latter, *read* alkanna instead of angustura.

Colouring matter of Anchusa tinctoria.

brown extract, obtained from the root at the commencement of the process, likewise contained ammonia; Bolley and Wydler consider the brown matter contained therein as identical with the residue just mentioned. This brown substance, which was easily soluble in water, but insoluble in ether or strong alcohol, was found to agree in composition with the formula $NH_4 O, C_{29} H_{15} O_{28}$.—The alcoholic solution of the pure red colouring matter was not altered in colour by boiling, but when mixed with some of the aqueous brown ammoniacal extract or some free ammonia, it changed colour rapidly.

Colouring Principle of Morinda Citrifolia.—Anderson(1) has examined the colouring principle of *Morinda citrifolia* (*Sooranjee*), to which he has given the name *morindin*. If the rind of the root be boiled with six times its weight of rectified alcohol, and the deep brown-red fluid obtained, filtered while hot, a brown flocculent precipitate is deposited, consisting of morindin and some red colouring matter; by subjecting the rind of the root repeatedly to the same treatment, the morindin is obtained gradually purer, and at last in small yellow needles. It is purified by crystallization, first from alcohol of 50 per cent, and then from alcohol slightly acidified with hydrochloric acid (to remove any inorganic substances). Morindin crystallizes from its alcoholic solution in small, concentrically grouped needles, which when dried and pressed together, form a sulphur-yellow mass, of silky lustre; it is slightly soluble in cold, but more soluble in hot alcohol (particularly when dilute); it is insoluble in ether and only slightly soluble in cold, but more soluble in hot water, from which solution it is deposited as a gelatinous mass; alkalies dissolve it with an orange-red, and concentrated sulphuric acid, with a deep purple colour; after some time the substance contained in the latter solution is altered, for, when precipitated therefrom by water, it is soluble in ammonia with a purple colour). The composition of morindin, dried at 100^0, is expressed by the formula $C_{28} H_{15} O_{15}$. A solution of morindin yields with basic acetate of protoxide of lead an easily decomposable carmine-coloured precipitate; with baryta, strontia, or lime, a red precipitate; with sesquichloride of iron, on addition of ammonia, a reddish precipitate. —When heated in a closed vessel, morindin fuses, and may be made to boil, with the evolution of orange vapours of a substance sub-

(1) Trans. of the Royal Soc. of Edinb. XVI, 435; Chem. Gaz. 1848, 313; Laurent and Gerhardt's Compt. Rend. des Trav. Chim. 1849, 35.

Colouring matter of Morinda Citrifolia.

liming in red needles, and the formation of a carbonaceous residue. Anderson called the sublimed substance *morindon*. It is not soluble in water, but is easily so in alcohol and ether; alkalies and concentrated sulphuric acid dissolve it with a violet colour; its ammoniacal solution yields with a solution of alum, a red, and with baryta-water, a cobalt-blue precipitate; the results of one analysis led Anderson to the formula $C_{28} H_{10} O_{10}$ for this substance.

Colouring Principles of Lichens.—Heeren(1), Kane(2), and Schunck(3) were the principal investigators, previously to 1847, of the lichen known by the name *roccella tinctoria*, from which the best archel is prepared. Heeren found it to contain a peculiar substance, which he called *erythrin*, and which was only converted into the colouring matter by the action of the air and ammonia. According to him, erythrin was converted, by boiling with alcohol, into a substance to which he gave the name *pseuderythrin*, he also found the lichen to contain a fatty acid, *roccellic acid*. Kane obtained a substance from the plant, similar in properties to Heeren's erythrin, which he called *erythrilin*, and another compound, possessing the properties of Heeren's pseuderythrin, to which he gave the name of *erythrin*. Schunck obtained (from the lichen of Angola and Madagascar) a substance similar to Heeren's erythrin and Kane's erythrilin, to which he gave the name *erythric acid*, and which formed, with oxide of ethyl, a compound corresponding to Heeren's pseuderythrin and Kane's erythrin; he confirmed the statement of Heeren, respecting roccellic acid.—Some new researches on the proximate constituents of *roccella tinctoria*, and of other lichens, have since been published by Stenhouse(4); conclusions, varying from those of Stenhouse, have been drawn by Strecker and Schunck from the facts communicated by him; Laurent and Gerhardt have likewise published their views respecting the composition and decompositions of various substances belonging to this class. We shall first report upon the statements of Stenhouse, and shall then bring forward the various other views.

(1) Jahrb. d. Ch. u. Ph. 1830, II, 313; Berzelius' Jahresber. XI, 275.

(2) Ann. Ch. Pharm. XXXIX, 25; Berzelius' Jahresber. XXII, 364.

(3) J. Pr. Chem. XXXVIII, 449; Ann. Ch. Pharm. LXI, 64; Berzelius' Jahresber. XXVII, 229.

(4) Ann. Ch. Pharm. LXVIII, 55; J. Pharm. [3] XV, 229 (in abstr.); Laurent and Gerhardt's Compt. Rend. des Trav. Chim. 1849, 127. A brief account of the results may be found in Phil. Mag. [3] XXXII, 300; J. Pr. Chem. XLV, 180; with some discrepancies in certain statements, which we have subjoined in the following foot-notes.

Researches on Roccella Tinctoria.—Stenhouse has published researches respecting the South American variety of *Roccella tinctoria*. The lichen was cut up, macerated for some hours with water, and mixed with hydrate of lime; the mixture was then stirred up, and allowed to settle, the yellowish liquid poured off, the residue again stirred up with water, and afterwards pressed out. On addition of hydrochloric acid to the aqueous solution, the colouring principle separated as a white gelatinous precipitate, which was washed, dried on a gypsum slab, and dissolved in warm alcohol (ebullition being avoided). On the solution cooling, it deposited the substance in stellated groups of small white needles. Stenhouse calls this substance *alpha-orsellic acid;* it does not dissolve in cold, and does so only to a small extent in boiling water; it is easily soluble in alcohol and ether; the alcoholic solution reddens litmus-paper distinctly. This acid possesses the characteristic property of assuming, immediately upon addition of hypochlorite of lime, a deep-red colour, which changes to brown and yellow, and then finally disappears entirely (in the presence of excess of hypochlorite of lime); the alpha-orsellic acid is rapidly oxidized by this substance, being converted into a dark-green uncrystallizable body. The ammoniacal solution of alpha-orsellic acid, when exposed to the air, assumes gradually a beautiful red colour. This acid has, when dried at 100°, the composition $HO, C_{32} H_{15} O_{13}$; it neutralizes the alkalies and alkaline earths, forming with them soluble crystallizable salts. The baryta-salt is procured by dissolving the acid in a slight excess of baryta-water, passing carbonic acid through the solution and extracting the orsellate of baryta from the precipitate by alcohol, from which it may be crystallized in small stellated groups of crystals, which have the formula $BaO, C_{32} H_{15} O_{13}$.—If the gelatinous impure orsellic acid, obtained by hydrochloric acid from the extract of the lichens with lime and water, be mixed with a little water, then carefully neutralized with lime or baryta and boiled until perfectly dissolved, some carbonic acid escapes and a new acid, *alpha-orsellinic acid* is formed (which would be again decomposed by continued ebullition). The liquid thus obtained is filtered, the acid precipitated from it, when cold, by hydrochloric acid and afterwards crystallized from dilute alcohol (which must not, however, be heated to ebullition), if necessary, after treatment with animal charcoal. The resulting crystals are possessed of a slightly acid and bitter taste, they redden litmus-paper distinctly; their aqueous solution evolves carbonic acid when boiled, and is then found to contain orcin. Alpha-orsellinic acid gives with hypochlorite of lime a transient reddish-blue colour; its ammoniacal solution becomes

Researches on Roccella Tinctoria.

Researches on Roccella Tinctoria.

red by exposure to the air. When dried at 100°, it has the formula HO, C_{16} H_7 O_7(1). The lime- and baryta-salts of this acid are much more soluble in water than the corresponding orsellates. The baryta-salt is obtained by the careful addition of small quantities of dry caustic baryta to a solution of the acid in slightly warmed alcohol, evaporation of the solution, and crystallization, (if excess of baryta be present, decomposition will ensue on evaporation, carbonate of baryta being deposited; if the acid be in excess, the residue obtained by evaporation must be neutralized); this salt is very soluble in water and dilute alcohol; it is decomposed at 100°; when dried *in vacuo*, it has the composition BaO, C_{16} H_7 O_7. By boiling alpha-orsellic acid for some hours with strong alcohol, a compound of oxide of ethyl is formed; if the liquid be concentrated considerably in a water-bath and the residue then boiled repeatedly with water and filtered, the compound is deposited, in the cold, in flat acicular or scaly crystals, which are purified by recrystallization; on submitting them to dry distillation, they evolve alcohol vapours, and orcin is found in the residue; they are not alpha-orsellate, but alpha-orsellinate of oxide of ethyl, C_4 H_5 O, C_{16} H_7 O_7; hence orsellic acid appears to undergo the same decomposition in this case as it does when boiled with a base or even with pure water.

The *roccella tinctoria* of the Cape of Good Hope yields, on extraction with lime and water and precipitation of this extract with hydrochloric acid, a gelatinous substance, which contains *beta-orsellic acid* and *roccellinin;* these compounds may be separated from each other, the beta-orsellic acid being tolerably soluble in hot water, while roccellin is insoluble.—*Beta-orsellic acid* separates from its aqueous solution in small crystals, which may be purified from a resinous substance and a fatty acid, by solution in lime- or baryta-water, precipitation with hydrochloric acid, &c. This acid is very similar in its properties to alpha-orsellic acid; when dried at 100°, it has, however, the composition HO, C_{34} H_{16} O_{14}: the formula of its baryta-salt (prepared by a process precisely similar to that for obtaining the alpha-orsellate) is BaO, C_{34} H_{16} O_{14}.—If beta-orsellic acid be neutralized with lime or baryta and boiled for a short time, it changes (exactly like alpha-orsellic acid, II. p. 65) into *beta-orsellinic acid,* which is analogous in its properties to alpha-orsellinic acid. If beta-orsellic acid be boiled with alcohol, a compound of ethyl is produced, which is not beta-orsellate of oxide of ethyl.—

(1) In the abbreviated memoir, published in the Phil. Mag. (Comp. II. 64), the formula of alpha-orsellinic acid is given as HO, C_{16} H_8 O_7.

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Roccellinin is obtained by boiling for a lengthened period with strong alcohol, the exhausted dried gelatinous precipitate mentioned above, evaporating to dryness and extracting the ethyl-compound resulting from beta-roccellic acid with boiling water, when the roccellinin remains behind; it is then dissolved by boiling it with a large quantity of strong alcohol, and separates from this solution, on its cooling, in white, hair-like crystals. Pure roccellinin is coloured yellowish-green by hypochlorite of lime, and dissolves freely in fixed alkalies and ammonia; these solutions do not, however, redden on exposure to the air. When roccellinin is boiled with baryta, no carbonate of baryta is formed. Its composition may be expressed by the formula $C_{38} H_{17} O_{15}$; Stenhouse was unsuccessful in his endeavours to obtain combinations of this substance, adapted for the determination of its atomic weight.

Investigation of Roccella Montagnei.—The *Roccella montagnei* (angola-lichen, which Schunck examined under the name of *Roccella tinctoria var. fuciformis*) was likewise investigated by Stenhouse. By exhausting it with lime and water and precipitating the extract with hydrochloric acid, he obtained *erythric acid*, and this in larger quantities than by following the directions given by Schunck, namely, by exhaustion of the lichen with boiling water, and repeated recrystallization from dilute alcohol of the deposit obtained on the cooling of the aqueous extract. Erythric acid behaves with hypochlorite of lime and in its ammoniacal solution, like alpha- and beta-orsellic acids; when dried at 100°, Stenhouse found it to have the formula $HO, C_{20} H_{10} O_9$ (Schunck had assigned to it the formula $C_{34} H_{19} O_{15}$); he did not succeed in preparing compounds of this acid with baryta or protoxide of lead of constant composition. The erythrate of oxide of ethyl, $C_4 H_5 O, C_{20} H_{10} O_9$, and the corresponding compound of oxide of methyl were obtained by boiling the acid with either alcohol or pyroxilic spirit and crystallizing the resulting compound from water; the aqueous solution of the ethyl-compound gives, with basic acetate of protoxide of lead, a white voluminous precipitate, which was found (when dried at 100°) to contain 70·8 to 71·0 per cent of protoxide of lead, 18·6 to 18·9 of carbon, 1·7 of hydrogen, and 8·4 to 8·7 of oxygen.—By saturating erythric acid with lime or baryta and boiling the neutral solution for a short time, two new bodies are formed; the one is an acid, similar to alpha- and beta-orsellinic acids, and termed by Stenhouse erythrelinic (*erythrelesic*) *acid;* it is obtained by this method in smaller quantities than the acids just mentioned, and is somewhat less soluble in water, from which it crystallizes in small micaceous laminæ; if it be boiled

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with water, carbonic acid is disengaged, colourless orcin being produced; if with excess of lime or baryta a red colouring matter is formed, in addition to orcin. The other product of the decomposition of erythric acid is a substance already described by Schunck as *picro-erythrin*. It is obtained by neutralizing erythric acid with lime or baryta, boiling, filtering off the erythrelinic acid precipitated by hydrochloric acid, considerably concentrating the filtrate, and allowing it to stand in a cold place; picro-erythrin is deposited in yellowish crystals, which are purified by washing with cold and recrystallization from boiling water, with addition of animal charcoal. It crystallizes in concretions of small colourless needles, is possessed of a bitter taste, and gives with hypochlorite of lime the same blood-red colouration as erythric acid; its ammoniacal solution becomes red when exposed to the air. Picro-erythrin was found by Stenhouse to have (when dried at 100^0) the formula $C_{34}H_{23}O_{20}$, (Schunck had assigned to it the formula $C_{34}H_{24}O_{20}$); the former chemist was unsuccessful in his attempts to obtain a lead-compound of constant composition, or a baryta-compound. Stenhouse does not agree with Schunck's view, according to which picro-erythrin is produced from erythric acid by the assimilation of water; he has convinced himself of the fact, that the conversion is always attended by the liberation of a considerable quantity of carbonic acid.—Schunck had stated that picro-erythrin, by boiling with excess of lime or baryta, was converted into orcin only; Stenhouse observed the simultaneous production of another substance, possessing a sweet taste, which he calls *erythroglucin*(1). To obtain the latter, the extract obtained by lime and water from the *Roccella montagnei* is boiled for some hours and then evaporated to one-third or one-fourth; after it has cooled, the lime is precipitated by carbonic acid and the filtered solution evaporated in a water-bath to syrupy consistence. This syrup consists principally of orcin and erythroglucin, mixed with a red colouring matter and a resinous substance; it is digested for some days with ether or strong alcohol, by which the orcin and a portion of the colouring matter are dissolved, the erythroglucin separating in small brilliant crystals, which are washed with cold and recrystallized from boiling alcohol. It forms large crystals, of the square prismatic system, as brilliant as diamonds, which are, according to Miller's determination P . ∞ P ∞, with a square pyramid of

(1) In an abstract of the memoir, to be found in the Phil. Mag. (Loc. cit. II. p. 64), this substance is called *pseudo-orcin*.

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the third order $\frac{3\,P\,3}{2}$ truncating one half of the edges of combination between P and ∞ P ∞ (P : P in the terminal edges = 141° 2 in the lateral edges = 123° 43′; P : ∞ P ∞ = 109° 29′; 3 P 3 : ∞ P ∞ = 138° 42′). This substance is neutral, it is soluble in water and alcohol, and is not acted upon by ammonia, hypochlorite of lime, free alkalies or their carbonates; it is not fermentable; its solution is not precipitated by salts of the protoxides of lead, silver, and copper. It loses water by desiccation *in vacuo* or at 100°; its composition is expressed by the formula $C_{10}\,H_{13}\,O_{10}$.

Stenhouse found the quantity of colouring matter in the *Roccella montagnei* of Angola to amount to about 12 per cent of the weight of the lichens; in the *Roccella tinctoria* from South America it amounted to about 7 per cent, and in the same lichen from the Cape of Good Hope, as also in the *Lecanora tartarea*, to 1½ to 2 per cent. As an approximative method for estimating the amount of colouring matter, Stenhouse recommends the determination of the amount of hypochlorite of lime requisite for the destruction of the colouring matter in an extract, prepared with milk of lime, from a known amount of the lichen.

Evernia Prunastri.—Another lichen, *Evernia prunastri*, had been investigated by Rochleder and Heldt(1), who found it to contain a substance which they considered as identical with lecanoric acid. Stenhouse conjectures that the substance examined by these chemists was probably not the genuine *Evernia prunastri*, or that the lichens growing in different countries vary in composition, as he found the *Evernia* occurring in Scotland, to contain perfectly different substances. The light-yellow extract, obtained with milk of lime, yielded, on neutralization with hydrochloric acid, a plentiful, flocculent, light-yellow precipitate, which was repeatedly warmed with very dilute alcohol, until about two-thirds of the precipitate had dissolved (the residue contained usnic acid); the solution solidified, on cooling, to a mass of small yellowish crystals, which were purified by treatment with animal charcoal and recrystallization. They consisted of a new acid, *evernic acid*. This substance is insoluble in cold, very slightly soluble in boiling water and easily soluble in alcohol and ether; its solutions redden litmus-paper. It yields, on dry distillation, an empyreumatic oil and a sublimate possessing the properties of orcin. A solution of the acid in excess of ammonia,

(1) Ann. Ch. Pharm. XLVIII, 1; Berzelius' Jahresber. XXIV, 382.

Evernia prunastri.

when exposed to the air, assumes generally a dark-red colour; hypochlorite of lime imparts to it a yellowish colour. This acid loses no water at 100°, its composition is expressed by the formula $HO, C_{34} H_{15} O_{13}$. By submitting a solution of this acid in excess of potassa, to a stream of carbonic acid, a mass of small crystals of evernate of potassa is obtained, which may be purified by recrystallization from weak alcohol, with addition of animal charcoal; the resulting crystals are white and of silky lustre; they lose no water at 100°, and have the formula $KO, C_{34} H_{15} O_{13}$. The baryta-salt, prepared in a similar manner, is only slightly soluble in water, but easily so in dilute alcohol; it crystallizes in small prisms, which, when dried at 100°, have the formula $BaO, C_{34} H_{15} O_{13}$.

If evernic acid be dissolved in a slight excess of caustic potassa, and the solution maintained in ebullition for some minutes, the resulting dark-brown fluid then submitted to a stream of carbonic acid, and when neutralized by it, evaporated, the potassa-salt of a new acid, *everninic acid*, is deposited in crystalline laminæ; it may be purified by washing with cold alcohol, solution in water, and afterwards in hot alcohol, with addition of animal charcoal. Hydrochloric acid produces, in an aqueous solution of this salt, a white, flocculent precipitate of everninic acid, which crystallizes from hot aqueous solutions, in long hair-like, silky needles. Everninic acid may be still better prepared by boiling evernic acid, for a short time, with a slight excess of baryta-water (when a quantity of carbonate of baryta is deposited), saturating the filtered solution with hydrochloric acid, and purifying the resulting precipitate by re-solution and digestion with animal charcoal. The mother-liquor contains orcin, resulting from the decomposition of evernic acid; everninic acid, when boiled with baryta-water, or solution of potassa, yields no orcin. Everninic acid is slightly soluble in cold, and considerably so in hot water; it dissolves freely in alcohol and ether; its solutions redden litmus-paper; when heated, it evolves an agreeable odour, and yields a white crystalline sublimate. Everninic acid is coloured merely yellow by a solution of hypochlorite of lime, and its ammoniacal solution is not reddened by exposure to the air. It loses no water *in vacuo*, or at 100°, and has the formula, $HO, C_{18} H_9 O_7$. The baryta-salt is prepared by boiling a solution of evernic acid in a slight excess of baryta-water, neutralizing by a stream of carbonic acid, evaporating the filtered liquid, purifying the precipitate formed, by exhausting with ether or cold alcohol (which dissolve orcin, together with a colouring matter), and recrystallizing the residue from dilute alcohol; long, hard, fans-haped groups of

four-sided prisms are thus obtained which, when dried at 100°, have the formula $BaO, C_{18} H_9 O_7$; when merely dried *in vacuo* they contain, however, 1 or 2 equivs. of water, according to the length of time they have been exposed. The silver-salt, $AgO, C_{18} H_9 O_7$, is obtained as a white precipitate, on addition of nitrate of protoxide of silver to everninate of ammonia. If evernic acid be boiled with strong alcohol, containing a few pieces of caustic potassa, until the whole is perfectly dissolved, and carbonic acid be passed into the liquid until the potassa is neutralized, and the liquid be then concentrated, long, brown, prismatic crystals are deposited, after some time (the mother-liquor containing orcin); these may be obtained pure by washing with water, and recrystallization from alcohol. The same compound is also formed by boiling evernic acid with absolute alcohol for eight or ten hours, and may be obtained, though in a state of less purity than by the former method, by washing the residue, resulting from the evaporation of the alcoholic solution, with water, to remove the orcin, and repeated recrystallization from dilute alcohol. The compound obtained by either method is tasteless and inodorous, soluble in alcohol and ether, insoluble in water; it fuses at 56°, and is separated unaltered from its solution in caustic potassa, by addition of hydrochloric acid; it corresponds in composition to everninate of oxide of ethyl, $C_4 H_5 O, C_{18} H_9 O_7$ (attempts to obtain the everninate of oxide of ethyl by boiling the acid with alcohol, saturated with hydrochloric acid, were unsuccessful). Evernia prunastri.

Stenhouse confirmed the formula $C_{38} H_{17} O_{14}$, as the true expression of the composition of usnic acid (dried at 100°), which was discovered by Knop, in 1843, and engaged the attention of Rochleder and Heldt at about the same period; he prepares it, by preference, from the *Cladonia rangiferina*, and the *Usnea florida;* and recommends exhaustion of the lichen with water and lime, precipitation of the extract with hydrochloric acid, and repeated recrystallization from strong alcohol, with addition of animal charcoal. (On the "Decomposition of usnic acid by destructive distillation," compare II. p. 73).

Orcin.—Stenhouse has also submitted to a new investigation, the orcin which is obtained from the colouring principles of the varieties of *Roccella tinctoria*, as well as from those of *Lecanora*, and from the substance yielded by *Evernia prunastri*, when submitted to destructive distillation, or when boiled with alkalies, with water alone, or with alcohol. He does not agree with the view proposed by Schunck, and afterwards adopted by Rochleder and Heldt, that orcin and carbonic acid are the only products of de-

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composition resulting on boiling lecanoric, or erythric acid, with excess of potassa; he considers the decomposition to be more complicated, intermediate acids being first formed, and the production of orcin from erythric and evernic acids being accompanied, moreover, by the formation of erythroglucin and everninic acid. Stenhouse recommends, as the best method for obtaining colourless orcin, that pure alpha- or beta-orsellinic acid, or erythrelinic acid, be boiled, from half an hour to one hour, with water, and the fluid rapidly evaporated, when colourless crystals of orcin separate on its cooling. For the preparation of larger quantities of orcin, when not required quite colourless, Stenhouse gives the following direction: the extract, obtained with lime and water from any of the varieties of *Roccella tinctoria,* or *Lecanora,* is boiled for some hours in an open dish, and evaporated to about one fourth, the lime is then precipitated by a current of carbonic acid, and the filtrate evaporated, when a thick syrup of fused orcin is obtained; this is boiled with strong alcohol, the filtered solution evaporated to crystallization, and the resulting product recrystallized repeatedly from anhydrous ether. Solution of hypochlorite of lime imparts to orcin a dark violet-red colour, which soon changes to brown, and then to yellow; this reaction is quite different from that exhibited by the orsellic acids, but very similar to those exhibited, under the same circumstances, by the intermediate acids.—Bromine acts energetically on an aqueous solution of orcin, and a red-brown crystalline mass is deposited. If bromine be added as long as there is any action, the crystalline mass separated from the fluid (which contains hydrobromic acid), washed with cold water, and recrystallized from dilute alcohol with animal charcoal, long, silky, colourless needles of a compound $C_{14} H_5 Br_3 O_4$ are obtained (*i. e.*, orcin in which 3 H are replaced by 3 Br, if the formula $C_{14} H_8 O_4$, proposed by Gerhardt(1) for anhydrous orcin, be adopted); this compound is easily soluble in alcohol and ether, insoluble in water; it fuses in boiling water, and becomes crystalline again on cooling(2). A similar compound is formed by

(1) Compt. Rend. des Trav. Chim. 1845, 286.

(2) Laurent and Gerhardt have investigated the same compound, and obtained the same results from its investigation; they state, moreover, respecting this substance, that, on its being heated, hydrobromic acid is disengaged, an oil distilling over, which solidifies on cooling, a considerable carbonaceous residue being left. (Ann. Ch. Phys. [3] XXIV, 315; Compt. Rend. XXVII, 164; J. Pr. Chem. XLV, 304.) We shall recur to the remainder of their memoir.—Stenhouse formerly assigned to the bromine-compound the formula $C_{16} H_{24} Br O_{13}$ (Loc. cit. II. 64), and adopted the formula $C_{16} H_{11} O_7$, for hydrated orcin.

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the action of chlorine on orcin; it could not, however, be obtained in a state of purity.

In a more recent investigation(1), Stenhouse has confirmed, by new analyses, the formula $C_{14}H_{10}O_6$ for hydrated orcin, and $C_{14}H_8O_4$ for the anhydrous substance. Of the various methods for obtaining orcin in an anhydrous state, namely: by distillation, exposure to 100°, repeated recrystallization from ether, and desiccation *in vacuo*, Stenhouse prefers the latter (although it takes most time), because, under this treatment, the orcin remains perfectly colourless. He could not obtain, of constant composition, the compound of protoxide of lead, described by Dumas and Schunck. Stenhouse has published a determination made by Miller, of the crystalline form of orcin. According to the latter, this substance belongs to the monoclinometric system, and occurs in the combination $\infty P . \infty P\infty . 0P . -P\infty$; ($\infty P : \infty P$ in the orthodiagonal principal section $= 102^0\,24'$; $\infty P\infty : 0P = 83^0\,57'$; $\infty P\infty : -P\infty = 136^0\,16'$; its cleavage is parallel to $\infty P\infty$ (2). — Stenhouse distinguishes common orcin by the name of *alpha-orcin*, from another substance *beta-orcin*, which is produced by the destructive distillation of the crude, previously dried, usnic acid. A large quantity of porous charcoal is obtained as residue; the beta-orcin partly subliming in large yellow crystals, partly passing over in the brown resinous fluid which distils over. It may be extracted from the latter by repeated treatment with much boiling water; the aqueous solution, evaporated to syrupy consistence, deposits brown-coloured crystals which are purified by pressure between bibulous paper, recrystallization from water with animal charcoal, and a second recrystallization from dilute alcohol. According to Miller's determination, beta-orcin crystallizes in the square prismatic system, in the combination $\infty P . P . \frac{1}{2}P . 0P . \infty P\infty . P\infty$ ($\frac{1}{2}P : 0P = 130^0\,57'$; $P : 0P = 113^0\,27'$; $P\infty : 0P = 121^0\,31'$; $P : \infty P = 156^0\,33'$; $\frac{1}{2}P : \infty P = 139^0\,3'$; $P\infty : \infty P\infty = 148^0\,29'$); the direction of cleavage was not perceptible. This substance is tolerably soluble in cold and easily

(1) Ann. Ch. Pharm. LXVIII, 99; J. Pharm. [3] XV, 308 (in abstr.); Laurent and Gerhardt's Compt. Rend. des Trav. Chim. 1849, 137. In a memoir agreeing for the greater part with this one, but of earlier date, (Phil. Mag. [3] XXXIII, 1; J. Pr. Chem. XLV, 185), Stenhouse adopted the formula $C_{21}H_{15}O_9$, for hydrated orcin, and $C_{21}H_{12}O_6$, for the anhydrous substance.

(2) The crystalline form of orcin has likewise been described by Laurent and Gerhardt, in the memoir just quoted; they observed it in the combination $\infty P . \infty P\infty . -P\infty$, and found, $\infty P : \infty P$, in the orthodiagonal principal section, $= 101^0\,30'$; $-P\infty : \infty P\infty = 136^0\,30'$.

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so in hot water, alcohol, and ether; it has a sweet taste, and is neutral; when heated it sublimes, evolving pungent vapours, without leaving a residue; when mixed with ammonia, carbonate of potassa, caustic potassa, or solution of hypochlorite of lime, it is rapidly reddened. It loses no water *in vacuo*; when thus dried, it has the formula $C_{38} H_{24} O_{10}$, which has, however, not been confirmed by the determination of its atomic weight; exposed to 100^0, it loses a quantity of water, and is itself partially volatilized at that temperature.

Observations on the Colouring Principles of Lichens in General.—The statements of Stenhouse have been subjected to an examination by Strecker and by Schunck; both of these chemists have been led to different conclusions, respecting the constitution of several of the substances mentioned in the preceding paragraphs.

Strecker(1) adopts the formula $C_{32} H_{14} O_{14}$ for alpha-orsellic acid, and retains Stenhouse's formula for alpha-orsellinic acid, $C_{16} H_8 O_8$; according to him, the former changes into the latter by the assimilation of water ($C_{32} H_{14} O_{14} + 2\,HO = 2\,C_{16} H_8 O_8$). Alpha-orsellic acid can likewise, according to Strecker's formula, be converted into orcin by the assimilation of water, and liberation of carbonic acid ($C_{32} H_{14} O_{14} + 2\,HO = 2\,C_{14} H_8 O_4 + 4\,CO_2$). The conversion of alpha-orsellinic acid into orcin, is effected simply by the evolution of carbonic acid ($C_{16} H_8 O_8 = C_{14} H_8 O_4 + 2\,CO_2$).—Strecker assigns to beta-orsellic acid the formula $C_{34} H_{16} O_{15}$, and assumes it to form, when boiled with alcohol, alpha-orsellinate of oxide of ethyl and roccellinin; the latter he represents by the formula $C_{18} H_8 O_7$; ($C_{34} H_{16} O_{15} = C_{16} H_8 O_8 + C_{18} H_8 O_7$).—He does not consider the formula of erythric acid as established; it might be $C_{20} H_{11} O_{10}$ (as assumed by Stenhouse), or $C_{28} H_{15} O_{14}$. In the first case, the following connection would exist between the products of decomposition of this substance. Strecker assumes erythroglucin to be $C_8 H_{10} O_8$; and picro-erythrin to be $C_{24} H_{16} O_{14}$; he moreover believes, the erythrelinic acid of Stenhouse to be identical with alpha-orsellinic acid, and the substances, considered by the latter as erythrelinic ethers, to be alpha-orsellinates.

$$\underbrace{2\,C_{20} H_{11} O_{10}}_{\text{Erythric acid.}} + 2\,HO = \underbrace{C_{14} H_8 O_4}_{\text{Orcin.}} + \underbrace{C_{24} H_{16} O_{14}}_{\text{Picro-erythrin.}} + 2\,CO_2.$$

$$\underbrace{2\,C_{20} H_{11} O_{10}}_{\text{Erythric acid.}} + 2\,HO = \underbrace{C_{16} H_8 O_8}_{\text{Alpha-orsellinic acid.}} + \underbrace{C_{24} H_{16} O_{14}}_{\text{Picro-erythrin.}}$$

(1) Ann. Ch. Pharm. LXVIII, 108.

$$\underbrace{C_{24}H_{16}O_{14}}_{\text{Picro-erythrin.}} + 2\,HO = \underbrace{C_{14}H_8O_4}_{\text{Orcin.}} + \underbrace{C_8H_{10}O_8}_{\text{Erythroglucin.}} + 2\,CO_2.$$

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In the second case :

$$2\,(\underbrace{C_{28}H_{15}O_{14}}_{\text{Erythric acid.}}) + 2\,HO = 2\,(\underbrace{C_{16}H_8O_8}_{\text{Alpha-orsellinic acid.}}) + \underbrace{C_{24}H_{16}O_{14}}_{\text{Picro-erythrin.}}.$$

Strecker retains for evernic and everninic acids the formulæ $C_{34}H_{16}O_{14}$, and $C_{18}H_{10}O_8$, according to which the decomposition of the former, by boiling with baryta-water, would be expressed by the equation :

$$\underbrace{C_{34}H_{16}O_{14}}_{\text{Evernic acid.}} + 2\,HO = \underbrace{C_{14}H_8O_4}_{\text{Orcin.}} + \underbrace{C_{18}H_{10}O_8}_{\text{Everninic acid.}} + 2\,CO_2.$$

Strecker dwells, moreover, on the property which alpha-orsellic, beta-orsellic, erythric, and evernic acids, possess in common, of yielding, when boiled with water, baryta-water, or alcohol, an acid ($C_{16}H_8O_8$, or the acid differing from it by C_2H_2, namely, $C_{18}H_{10}O_8$), together with another substance, which is either an acid or a neutral body. With respect to the acid obtained from *Lecanora Parella*, he believes it to be formed from an acid similar to those above-mentioned, which, by boiling with baryta or alcohol, would be decomposed into lecanoric acid ($C_{16}H_8O_8$) and parellic acid, which has probably the formula $C_{18}H_6O_8$.—As regards the relation of beta-orcin to usnic acid, Strecker thinks that the formula of usnic acid might be changed to $C_{38}H_{18}O_{14}$, and that of the crystallized beta-orcin to $C_{34}H_{18}O_6+3\,HO$, in which case the formation of the latter would be explained by the equation $C_{38}H_{18}O_{14} = C_{34}H_{18}O_6+4\,CO_2$.

Schunck(1) is of opinion, that on boiling the substances named erythrin, erythrilin, erythric acid, alpha- and beta-orsellic acids, with alcohol, the same substance is produced in all cases—namely, a body identical with that, obtained by boiling lecanoric acid with alcohol, designated by him as lecanorate of oxide of ethyl, and which he considers as composed according to the formula C_4H_5O, $C_{18}H_8O_8$; he likewise thinks the so-called pseudo-erythrin to be identical with this substance. He believes that the various lichens here referred to, certainly contain different acids, but that they are all related to each other, in being conjugate acids, consisting of lecanoric acid and various adjuncts.—According to this view, erythric acid, to

(1) Phil. Mag. [3] XXXIII, 249 ; J. Pr. Chem. XLVI, 18.

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which Schunck assigns the formula $C_{42} H_{23} O_{21}$, would be lecanoric acid ($C_{18} H_8 O_8$) + picro-erythrin — HO (Schunck now, like Strecker, adopts the formula $C_{24} H_{16} O_{14}$, for the latter compound, and proposes for it the name *erypicrin*); picro-erythrin would, by assimilation of 12 HO, and elimination of $2 CO_2$, become erythroglucin (also called pseudo-orcin by Stenhouse, and for which Schunck proposes the name eryglucin, and the formula, $C_{22} H_{28} O_{22}$); he endeavours to explain, by these assumptions, the decompositions which erythric acid undergoes under various circumstances. He considers alpha- and beta-orsellic acids to be identical in composition, and assigns to them the formula $C_{34} H_{18} O_{14} = C_{18} H_8 O_8$ (lecanoric acid) + $C_{16} H_{11} O_7$ (Schunck's formula for crystallized orcin) — HO.—He also regards alpha- and beta-orsellinic acids as identical, and their composition to be expressed by the formula $C_{18} H_9 O_9$ (lecanoric acid + HO). Schunck here states, that lecanoric acid, after dissolution in caustic baryta and reprecipitation, contained 1 eq. more water than it did before, having become $C_{18} H_9 O_9$.—To evernic acid Schunck assigns the formula $C_{36} H_{17} O_{15} = C_{18} H_8 O_8$ (lecanoric acid) + $C_{18} H_{10} O_8$ (everninic acid) — HO.

Laurent and Gerhardt(1) assign to anhydrous lecanorin (which name had been changed by Heldt and Rochleder, and by Schunck, to lecanoric acid) the formula $C_{32} H_{14} O_{14}$, to crystallized lecanorin $C_{32} H_{16} O_{16}$, to pseudo-erythrin $C_{20} H_{12} O_8$, to orcein $C_{14} H_7 N O_6$. According to them the decomposition of lecanorin, by boiling with baryta-water, is expressed by the equation:

$$\underbrace{C_{32} H_{14} O_{14}}_{\text{Lecanorin.}} + 2\,HO = 2\,(\underbrace{C_{14} H_8 O_4}_{\text{Orcin.}} + 2\,CO_2).$$

Its decomposition, when boiled with alcohol and alkali, is explained by the equation:

$$\underbrace{C_{32} H_{14} O_{14}}_{\text{Lecanorin.}} + \underbrace{C_4 H_6 O_2}_{\text{Alcohol.}} = 2\,CO_2 + \underbrace{C_{14} H_8 O_4}_{\text{Orcin.}} + \underbrace{C_{20} H_{12} O_8}_{\text{Pseudo-erythrin.}}.$$

the decomposition of pseudo-erythrin, by boiling with alkalies, by:

$$\underbrace{C_{20} H_{12} O_8}_{\text{Pseudo-erythrin.}} + 2\,HO = 2\,CO_2 + \underbrace{C_4 H_6 O_2}_{\text{Alcohol.}} + \underbrace{C_{14} H_8 O_4}_{\text{Orcin.}}.$$

and the production of orcein from orcin, by the action of air and ammonia, by the equation:

$$\underbrace{C_{14} H_8 O_4}_{\text{Orcin.}} + 6\,O + NH_3 = \underbrace{C_{14} H_7 N O_6}_{\text{Orcein.}} + 4\,HO.$$

(1) Loc. cit. II. 72.

Gerhardt(1) proposes the formula $C_{16} H_{10} O_4$, for beta-orcin, according to which it would differ from orcin by $C_2 H_2$.

Colouring matter of madder-root.

Colouring Matter of Madder-root.—The madder-root (*Rubia tinctoria*) has, for a lengthened period, engaged the attention of many chemists. In 1823 Kuhlmann(2) stated that madder contained a crystallizable colouring principle; in 1826 Robiquet and Colin(3) discovered in it a sublimable substance, *alizarin;* Kuhlmann(4) published, in 1827, the discovery of a peculiar yellow colouring matter, *xanthin;* Runge(5) described, in 1835, five substances obtained by him from madder: *madder-purple, madder-red, madder-orange, madder-yellow,* and *madder-brown,* and stated that it contained, moreover, two other substances, *madderic acid,* and *rubiacic acid.* In 1846 Schiel(6) proposed for madder-purple the formula $C_{28} H_{10} O_{15}$, and for madder-red the formula $C_{28} H_9 O_9$.—In the years 1847 and 1848 new statements were published by Schunck, Higgin, and Debus on this subject, which do not, however, accord with each other. We shall confine ourselves here only, to the matter which is important in a theoretical point of view, and refer to our Report on Technical Chemistry, for the bearing of these researches on practical purposes.

Schunck(7) performed his experiments with madder-root, which had been gathered a few weeks previously. The coarsely powdered roots were boiled for some hours with water and the fluid strained while hot; it was dark brown and became bright-yellow on addition of an acid, with deposition of a dark brown substance. This comparatively small precipitate contained the whole of the colouring matter originally in the fluid, it consisted of seven different substances: two colouring matters (*alizarin* and a new colouring matter, *rubiacin*), two resins, one bitter principle (*rubian*), pectic acid and a dark brown substance (probably oxidized extractive matter).—

(1) Laurent and Gerhardt's Compt. Rend des Trav. Chim. 1849, 138.
(2) Ann. Ch. Phys. [2] XXIV, 225; Berzelius' Jahresber. IV, 207.
(3) J. Pharm. XII, 407; XIII, 447; Berzelius' Jahresber. VII, 265; VIII, 273.
(4) J. Pharm. XIV, 354; Berzelius' Jahresber. VIII, 275.
(5) Verh. Gew. Bef. Pr. 1835, Hft. 2; Berzelius' Jahresber. XVI, 262.
(6) Ann. Ch. Pharm. LX, 74; Berzelius' Jahresber. XXVII, 472.
(7) Most complete in Ann. Ch. Pharm. LXVI, 174, (Laurent and Gerhardt's Compt. Rend. des Trav. Chim. 1849, 215, in abstr.); we have followed principally the above Memoir; a few discrepant statements are found in a short Memoir, published almost at the same time (in Phil. Mag. [3] XXXIII, 133; J. Pr. Chem. XLV, 286. Earlier statements of Schunck, containing likewise some discrepancies from those published more recently, are to be found in Phil. Mag. [3] XXXI, 46; J. Pr. Chem. XLII, 13.

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By exhausting this precipitate with boiling water, alizarin, rubian, pectic acid, and a little resin were dissolved, while rubiacin, the principal part of the resin and the dark-brown substance remained behind; the liquid, strained while boiling, deposited, on cooling, alizarin and some resin, in dirty-red flakes; the insoluble residue had become lighter in colour, and crystalline particles (rubiacin) were perceptible therein.—On treating the dark-brown precipitate with alcohol, alizarin, rubian, and the two resins were dissolved, while pectic acid and the dark-brown substance remained behind.—When boiled with dilute nitric acid, the dark-brown precipitate became light- or orange-yellow (nitrous fumes being evolved), and alizarin, rubian, and the dark-brown substance were oxidized, while rubiacin, the two resins and pectic acid remained unaltered; the precipitate, after this treatment, had no colouring properties, which it possessed to a considerable extent in its original (dark-brown) state.

Schunck found the following method best for separating the substances contained in this dark-brown precipitate. It is washed with cold water, until the whole of the acid employed for its preparation is removed; it is then treated, while yet moist, with boiling alcohol, and the dark yellowish-brown liquid filtered while boiling; the brownish-purple, flocculent residue is repeatedly treated in this manner, until the filtrate has only a slight yellow tinge. A dark-brown resin often separates, in the form of powder, from the hot alcoholic solution as it cools. The solution is again heated to ebullition and mixed with freshly precipitated hydrate of alumina, by which it is perfectly decolourized, the alumina assuming a red colour, as it carries down with it alizarin, rubian, rubiacin, and a portion of the resins. The coloured alumina is washed with alcohol and treated with a boiling concentrated solution of carbonate of potassa, which dissolves the whole of the substances combined with the alumina, except the alizarin, the liquid assuming a deep red colour; the residue, consisting of the alumina-compound of alizarin, together with an excess of the former, is repeatedly exhausted with carbonate of potassa, until the liquid has only a slightly purple tinge. The residual (deep brown-red) alizarin-alumina is decomposed by boiling hydrochloric acid, when the *alizarin* remains as a light-red, somewhat crystalline powder. This is washed, crystallized from boiling alcohol and separated from a brown pulverulent resin, with which it is sometimes mixed, by agitation with alcohol, in which the latter remains suspended for a longer period.—Hydrochloric acid precipitates from the (dark-red) carbonate of potassa-solution, with which the alumina has been boiled, rubiacin, rubian, and the two

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resins, in brown flakes. When this precipitate is washed with water, the rubian commences to dissolve as soon as the hydrochloric acid is removed; the yellow wash-water is collected as long as it is coloured and has a bitter taste; it yields, on evaporation, *rubian*, in the form of a transparent yellow or reddish-brown extract. The residual portion, after treatment with water, consists of rubiacin and the two resins; it is mixed with the residue of the alcoholic solution, (containing likewise resins), which had been treated with hydrate of alumina, and the whole boiled with a solution of sesquichloride of iron or nitrate of the sesquioxide, when rubiacin dissolves, but is principally converted into *rubiacic acid*, which is likewise retained in solution, in combination with sesquioxide of iron; besides this, the alpha-resin dissolves, while the beta-resin remains insoluble, in combination with sesquioxide of iron, as a dark-brown flocculent substance, which is separated from the liquid and decomposed by hydrochloric acid, when the *beta-resin* separates: it is deposited from its solution in boiling alcohol, on cooling, as a brown powder. The dark, reddish-brown liquid, filtered off from the combination of the beta-resin with sesquioxide of iron, yields with hydrochloric acid a light-yellow precipitate, which becomes brown while being washed with water, consisting of rubiacin, rubiacic acid and alpha-resin; it is treated with boiling alcohol while yet moist. In this operation *rubiacic acid* remains undissolved; it is first washed with boiling alcohol and then boiled with carbonate of potassa, when a blood-red solution is obtained, which, after being freed from any sesquioxide of iron by filtration, deposits on cooling, light-red crystals of rubiacate of potassa, which may be purified by recrystallization. Rubiacin and the alpha-resin yield, on the other hand, a deep brownish-yellow alcoholic solution; from this liquid (filtered while hot) *rubiacin* separates as a powder of minute lemon-yellow crystals, which can scarcely be purified by recrystallization; it should be repeatedly treated with sesquichloride of iron, &c., as just described; but it can only be obtained quite pure by preparation from rubiacate of potassa, in the manner mentioned below. Rubiacin and *alpha-resin* remain in solution, the latter may be obtained pure (as a dark reddish-brown mass) by evaporating the solution and adding the residue to boiling water, when the alpha-resin sinks to the bottom of the vessel in large brown drops, while rubiacin remains suspended in the liquid as a powder, and may be poured off; this operation must be repeated several times.

The residue, remaining after treatment of the dark-brown pre-

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cipitate (II. p. 78) with boiling alcohol, is of a dark purple-brown colour. Boiling water extracts from it (brown-coloured) *pectic acid*, leaving a dark-brown residue, soluble only in alkalies (with a dark-brown colour), from which solution it is precipitated by acids in dark-brown flakes, which leave much ash when burned. Schunck considers the brown colour of the precipitate produced by acids in decoctions of madder, to arise from this substance, which he believes to be formed by the action of the air upon some constituents of the decoction, and to be identical with a substance produced by the action of the air upon the extractive matter of madder, to be described below.

The liquid, from which the dark-brown precipitate (II. p. 77), produced by an acid (oxalic acid) has been separated, is of a light-yellow colour (after removal of the oxalic acid by lime); when evaporated on a sand-bath, it becomes brown and yields a thick deep-brown indesiccative syrup. Water dissolves it partially, leaving a dark-brown pulverulent residue. The solution shows, on repeated evaporation, the same behaviour; and Schunck is inclined to ascribe the formation of the powder to the action of the air upon some soluble substance. The syrup yields, on being burnt, an ash, the soluble portion of which consists principally of potassa, together with carbonic, sulphuric and hydrochloric acids, besides traces of lime and magnesia, while the insoluble portion contains the carbonates of lime and magnesia, a little alumina, phosphate of lime and phosphate of magnesia. The aqueous solution of the brown syrup contains neither tannin nor gum; it has an acid reaction (probably due to the presence of phosphoric acid). With acetate of protoxide of lead it gives a dingy flocculent precipitate, yielding, after decomposition of its solution by hydrosulphuric acid and evaporation, an acid, dark-brown syrup and a brown powder; the supernatant liquid, freed from protoxide of lead by hydrosulphuric acid and evaporated over sulphuric acid, yields an indessicative, yellow, honey-like residue, which is probably Kuhlmann's xanthin or Runge's madder-yellow. Sugar could not be obtained from this fluid; although, the decoction of a larger quantity of madder, when concentrated and mixed with yeast, gave rise to the formation of alcohol).

Boiling potassa extracted from madder-root, previously perfectly exhausted with boiling water, brown-coloured pectic acid; boiling hydrochloric acid dissolved oxalate of lime. On treating with a solution of potassa the madder-roots which had been exhausted with hydrochloric acid and washed with water, a dark-red solution is

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obtained, which contains alizarin, pectic acid, beta-resin, and probably also rubiacic acid; Schunck believes that these substances, which may be extracted from the roots by treatment first with hydrochloric acid and then with a solution of potassa, exist therein in combination with lime and magnesia.—Schunck states that, after treatment of the roots with water, hydrochloric acid and potassa, there remains nothing but woody fibre.

Schunck has submitted, moreover, to a closer examination some of the substances found by him in the madder-root.

Alizarin crystallizes from its alcoholic solution in long, transparent, lustrous, brownish-yellow prisms (C_{14} H_5 O_4 + 3 HO), (comp. II. p. 89, the article on lizaric acid); when heated on platinum-foil, it fuses and then burns with a bright flame. The crystals lose their water (3 HO) at 100°, becoming opaque and dark-red. At 215° alizarin commences to sublime, a considerable residue of carbon being always left, however carefully the experiment may be performed; the sublimed alizarin, C_{14} H_5 O_4, is light orange-yellow, transparent and lustrous. Alizarin is slightly soluble in water (the solution in pure water is yellow; in water containing small quantities of alkalies or alkaline earths, reddish), more soluble in alcohol, (yielding a yellow solution, from which small crystals are precipitated by water) and also in ether. It dissolves with a brilliant purple colour in the caustic alkalies and their carbonates, from which it is precipitated in deep orange-coloured flakes, by acids. The whole of the ammonia is expelled from the ammoniacal solution of alizarin during evaporation; this solution yields, with chloride of barium or chloride of calcium, purple precipitates, BaO, HO, C_{14} H_4 O_3 or CaO, HO, C_{14} H_4 O_3, which turn almost black on desiccation. They retain, even at 100°, the water expressed in the preceding formulæ. A solution of alizarin in potassa is decolourized by alumina, with the formation of a reddish-purple precipitate, and likewise by sesquioxide of iron, with the production of a dark purple-coloured compound. An alcoholic solution of alizarin yields with an alcoholic solution of acetate of protoxide of lead, a purple, afterwards deep-red, precipitate, PbO, C_{14} H_4 O_3. Schunck is of opinion, that the colouring property of madder is solely due to the alizarin, (comp. foot-note, II. p. 85), and that Runge's madder-purple and madder-red are mixtures of alizarin with varying quantities of the two resins.—Alizarin, suspended in water, assumes a yellow colour on addition of hypochlorite of lime, and yields, after this treatment, a colourless sublimate on being heated. Hydrochloric acid has no action upon it; sulphuric acid

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dissolves it with a dark yellowish-brown colour, which is not altered even by the application of heat; addition of water precipitates it from this solution in deep orange-coloured flakes. Dilute nitric acid, nitrate of sesquioxide of iron, or sesquichloride of iron, convert alizarin into alizaric acid(1). The latter is obtained by heating alizarin or garancin (madder-root treated with hot sulphuric acid and washed) with nitric acid, of spec. grav. 1·20, as long as red fumes are evolved; the reddish-yellow fluid is then made to crystallize when oxalic and alizaric acids are obtained in crystals; these are washed, dissolved in boiling water, the solution neutralized with lime, and filtered, the filtrate mixed with hydrochloric acid and crystallized; the resulting yellow mass is then freed from chloride of calcium by washing, redissolved in hot water, and the resulting yellow solution decolourized by animal charcoal and crystallized. Alizaric acid, $C_{14}\ H_5\ O_7$, is thus obtained in transparent, colourless, flat rhombic plates, the solution of which has an acid reaction (in case the crystals are not quite colourless, they may be purified still farther by dissolving them in boiling water and passing chlorine into the solution). Alizaric acid is easily soluble in alcohol; it is not decomposed by chlorine. Its aqueous solution yields with sesquichloride of iron, a yellowish precipitate, with acetate of protoxide of lead a white one, insoluble in acetic acid; with nitrate of protoxide of silver it gives no precipitate, but on addition of a little ammonia, a white flocculent powder is thrown down, which becomes crystalline after some time. Most alizarates are soluble; the potassa-salt yields upon evaporation a crystalline mass; the lime-salt forms lustrous prisms; the baryta-salt (dried at 100°, probably $2\ BaO,\ HO,\ C_{14}\ H_4\ O_6$) crystallizes in needles of silky lustre; the salt of protoxide of silver (containing probably 2 AgO to 1 eq. of acid) crystallizes upon the cooling of the hot saturated aqueous solution; the salt of protoxide of lead, ($2\ PbO,\ C_{14}\ H_4\ O_6$), is a white insoluble powder.—On heating alizaric acid with caustic lime, a yellow oil, of an odour similar to that of benzole, is formed, which, after some time, solidifies to a crystalline mass. —Alizaric acid, when heated in a glass tube, fuses, and is completely volatilized; the sublimed *pyro-alizaric acid* has, according to Schunck, the composition $C_{28}\ H_7\ O_{11}$; he explains its formation by

(1) The above are Schunck's statements on alizaric acid. Gerhardt (in his and Laurent's Compt. Rend. des Trav. Chim. 1849, 220, 222) supposes that alizaric acid is identical with Laurent's phtalic acid ($C_{16}\ H_6\ O_8$), and has supported his opinion by qualitative experiments. Analyses performed by Strecker, in the Giessen laboratory, have also proved the identity of alizaric and phtalic acid.

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the equation $2\,C_{14}\,H_5\,O_7 = C_{28}\,H_7\,O_{11} + 3\,HO$(1). The reactions of pyro-alizaric acid perfectly agree with those of alizaric acid, and the former appears capable of being reconverted into the latter by solution in water and recrystallization.

Rubiacin, the production of which has already been mentioned II. p. 79, can only be obtained perfectly pure, by dissolving rubiacate of potassa in boiling water, adding a small excess of potassa, submitting the solution to a stream of hydrosulphuric acid for a considerable time, then precipitating by chloride of barium, and decomposing the resulting purple precipitate (a combination of rubiacin with baryta) by hydrochloric acid, when rubiacin is left as the residue. (Runge's madder-orange is, according to Schunck, impure rubiacin.) Rubiacin crystallizes from boiling alcohol in beautiful lustrous plates and needles, the colour of which is yellow, tending more to green than red. Schunck assigns to rubiacin, dried at 100°, the formula $C_{31}\,H_9\,O_{10}$. It fuses on being heated; carefully heated, between two watch-glasses, it sublimes completely, forming yellow scales. It is only slightly soluble in boiling water, which precipitates it in yellow flakes from its light-yellow alcoholic, and its yellow sulphuric acid solution (the latter may be boiled without any blackening, or disengagement of gas). It dissolves in boiling carbonate of potassa with a blood-red, and in caustic potassa with a purple colour; its ammoniacal solution yields dingy-red precipitates with chloride of barium, and chloride of calcium. Hydrate of alumina decolourizes a boiling solution of rubiacin in alcohol, an orange-coloured compound being formed, which dissolves easily in caustic potassa, with a purple colour. Rubiacin acts only as a very feeble dye on mordantized cloth.(2) It is completely soluble in a boiling solution of sesquichloride of iron, or nitrate of sesquioxide of iron, yielding a dark, brownish-red liquid, which becomes yellow upon addition of strong acids, depositing yellow flakes of *rubiacic acid*. The latter is purified by combining it with potassa, dissolving the pure potassa-salt in boiling water, and adding hydrochloric acid, when the rubiacic acid is precipitated as a lemon-yellow powder, having, when dried at 100°, the formula $C_{31}\,H_8\,O_{16}$(3); it is only slightly soluble in water and alcohol, and is converted into

(1) In Phil. Mag. [3] XXXIII, (comp. II. p. 77), Schunck assigns to pyro-alizaric acid the formula $C_{14}\,H_3\,O_5$.

(2) Compare foot-note, II, p. 85.

(3) In Phil. Mag. [3] XXXIII, 142, Schunck assigns to rubiacic acid the formula $C_{31}\,H_9\,O_{17}$, without stating at what temperature the substance of this composition was dried.

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rubiacin by solution in alkalies, and treatment with hydrosulphuric acid. Rubiacate of potassa ($KO, C_{31} H_7 O_{15}$) crystallizes from its aqueous solution in light brick-red needles and prisms, which are also soluble in alcohol; the aqueous solution yields, with chloride of calcium, an orange coloured precipitate; with chloride of barium, alum, the nitrate of protoxide of silver, the nitrates of suboxide and protoxide of mercury, protochloride and bichloride of tin it produces yellow precipitates, and with acetate of protoxide of lead, and sulphate of protoxide of copper, red precipitates.

Schunck has given the name *rubian* to the bitter principle of madder, the only nitrogenous constituent he found therein. Its preparation has been described II. p. 79; rubian is purified from an admixture of pectic acid by treatment with alcohol, in which the former dissolves. When in thin layers it is transparent and yellow, but in larger quantities it is dark-brown. Its concentrated boiling aqueous solution congeals to a jelly on cooling. It fuses on being heated, and evolves yellow vapours, which condense to crystals, resembling rubiacin. Acids produce in the aqueous solution a yellow precipitate, the alkalies redden it; lime and baryta-water give a red, sesquichloride of iron a red-brown, acetate of protoxide of lead a brown precipitate; protochloride of mercury, tincture of galls, and solution of gelatin produce no precipitate in it. Rubian evolves ammonia, when boiled with solution of potassa. Its aqueous solution dyes cloth, prepared with a mordant, so very feebly, that it cannot be considered as a dye. By evaporating the aqueous solution in contact with the air, with the assistance of heat, a dark-brown resinous substance separates, which resembles the alpha-resin; when heated in a glass tube, it yields a plentiful, yellow, crystalline sublimate, resembling rubiacin.

The *alpha-resin* (II. p. 79) is dark-brown, or reddish-brown, brittle in the cold, soft at 65°, and fuses at 100° to dark-brown drops. It is slightly soluble in boiling water; its solution in alcohol is of an orange colour, that in the caustic alkalies, or their carbonates, of a purple-red colour. The ammoniacal solution yields purple precipitates with the chlorides of barium and calcium, and dingy-red ones with alum and nitrate of protoxide of silver. The alkaline solution is bleached by chlorine, and then ceases to be precipitated by acids. This resin appears to be rather more injurious than useful in the process of dyeing, by imparting a disagreeable yellow colour to the unprepared parts of the cloth which are to remain white. The light-brown *beta-resin* (II. p. 79) becomes soft, and only agglutinates at 100°, it is slightly soluble in boiling water, with a yellow, in

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alcohol with a dark-yellow, and in caustic alkalies and their carbonates, with a dingy-red colour, which is destroyed by chlorine; its ammoniacal solution gives dingy-yellow precipitates with the chlorides of barium and calcium. This resin has the same effect upon cloth prepared with a mordant, as the alpha-resin.—*Xanthin* (II. p. 80), which Schunck did not succeed in obtaining pure, has likewise, according to his observations, an injurious action in dyeing, inasmuch as its solution, becoming brown in contact with the air, imparts a shade of brown to the cloth to be dyed.

With respect to the process of dyeing with madder, and the utility of the presence of a certain quantity of lime in the dye, Schunck believes the alizarin to be the only active dyeing principle, and the addition of lime to serve merely for retaining pectic acid, rubian, and the resins, which would otherwise combine in preference with the alumina or sesquioxide of iron in the mordants(1). He ascribes the greater dyeing power of garancin (II. p. 82) to the liberation of a portion of the dyeing principle, existing in the madder-root in combination with lime and magnesia, by the action of the hot sulphuric acid, as also to the removal of the injurious xanthin by washing.

Higgin(2) does not agree with Schunck, in considering alizarin to be the only efficient dyeing principle amongst the constituents of madder-root, and ascribes to rubiacin and xanthin essentially co-operative powers. He rejects the method of boiling madder in water for the examination of its constituents, as products of decomposition are thus obtained. He exhausts madder with hot water, in a funnel-bag, until the latter passes through nearly colourless; to the extract, after cooling, he adds sulphuric acid, which produces a flocculent precipitate, while the supernatent liquid is coloured yellow. The precipitate consists of rubiacin, alizarin, and some pectin. Higgin mixes it with chalk, and boils the mixture with water, until this no longer assumes a dark, but on the contrary, a light-red colour. This aqueous solution contains rubiacin, which is precipitated, of a greenish-yellow colour, by sulphuric acid, and recrystallized from alcohol. He finds rubiacin essentially of the same properties as described by Schunck,

(1) In Phil. Mag. [3] XXXIII, 143, Schunck, on the contrary, states, that alizarin is not the only active dyeing principle in madder, but that rubiacin is likewise possessed of dyeing properties; that the latter substance, in the free state, does not impart a colour to cloths, but that it does so, when previously mixed with a little lime or an alkaline base. He farther states, that in the process of dyeing the free alizarin is first taken up, and then the combination of rubiacin with lime, and that the latter brightens the colour of the dye, and renders it more capable of withstanding the action of soap and acids.

(2) Phil. Mag. [3] XXXIII, 282; J. Pr. Chem. XLVI, 1.

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and states, moreover, that it dissolves with an orange colour in a boiling solution of alumina, from which it does not separate in the cold (unless much alizarin be present), and that it produces, with lime, a tolerably soluble compound.—The *alizarin* remains undissolved in combination with lime, and may be separated therefrom by dilute hydrochloric acid. Higgin's statements respecting this substance agree essentially with those of Schunck; the former remarks in addition, that alizarin is very easily soluble in a hot solution of alum, and that only a small quantity of the substance separates from this solution on cooling.

The yellow fluid, separated from the flocculent precipitate, contains xanthin, a small quantity of alizarin, rubiacin, some sugar and salts of organic and inorganic acids. This solution is neutralized with carbonate of soda, the rubiacin and alizarin contained therein are separated by digestion for half an hour, at about 54°, with a small quantity of hydrate of alumina, and the phosphoric and sulphuric acids removed from the filtrate by baryta-water. Higgin then precipitates the xanthin, with basic acetate of protoxide of lead, as a red combination, which he frees from other lead-compounds, simultaneously formed, by washing with water. The residuary lead-compound being decomposed by hydrosulphuric acid, the xanthin remains adhering to the protosulphide of lead; this is washed with cold water, and the xanthin dissolved out by boiling water; the solution is then evaporated, (neutralized, if necessary, with baryta), and the xanthin extracted from the residue with absolute alcohol. Xanthin, thus prepared, is a dark-brown, gummy, deliquescent substance, of a bitter taste, soluble in water with a yellow colour, easily soluble in alcohol, and slightly so in ether; it dissolves in alkalies, with a red colour. It possesses the characteristic property of yielding a grecnish, pulverulent deposit, when its aqueous solution is boiled with a little sulphuric, or hydrochloric acid; the concentrated aqueous solution, when mixed with a large quantity of these acids, assumes gradually, even in the cold, a green colour. Dry xanthin forms, with concentrated sulphuric acid, an orange-coloured solution, becoming more of a crimson on being heated; water precipitates therefrom yellow flakes, which appear to be rubiacin. If the solution in sulphuric acid be heated for about an hour, it becomes brown, and yields, with water, a brown pulverulent precipitate, insoluble in ammonia. Cloth mordantized with alumina, is dyed yellow by xanthin.

The freshly prepared cold aqueous extract of madder has, at first, a sweet taste, which becomes afterwards bitter; like the solution of xanthin, it dyes white cotton deep-yellow; the extract deposits, after

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a few hours, a flocculent, orange-red precipitate, of highly colouring properties; the liquid has afterwards a pure sweet taste, and imparts to white cotton a reddish dye. The extract of madder, prepared with cold water, contains, according to Higgin, xanthin, which passes over, by spontaneous decomposition, first into rubiacin, and then into alizarin. He does not believe this transformation to arise from oxidation, but probably from a kind of fermentation, induced by a nitrogenous constituent of madder; the transition proceeds more rapidly at 49° to 54°. He states, that the extract obtained from madder, with boiling water, does not lose its bitter taste, or deep-yellow colour, even after a long time. The formation of alizarin from xanthin takes place, likewise, in the process of madder-dyeing, in which the temperature is raised only very gradually.

Higgin succeeded in obtaining uncrystallizable sugar from madder, by precipitating, with dilute sulphuric acid, the protoxide of lead in the solution from which the xanthin had been separated (II. p. 86), evaporating the solution, and extracting the sugar from the residue with alcohol. He considers the resins, found by Schunck, to be products of decomposition, formed by boiling madder with water. He does not believe the colouring matters of madder to be partially combined with lime, as they may be perfectly extracted by repeated boiling with alcohol. In garancin (II. p. 82), he found merely alizarin, and neither xanthin, rubiacin, pectin, nor any nitrogenous substances. According to him, garancin is better adapted for dyeing purposes, on account of the absence of these substances; he ascribes, with Schunck, the higher dyeing properties of this substance to the removal of the lime-salts.

Debus(1) obtained the following results, in an examination of the madder of Zealand. The fluid, obtained by boiling the root three or four times with from 15 to 20 times its volume of water, was boiled with excess of hydrate of protoxide of lead, by which one portion was dissolved, another forming insoluble combinations with the colouring matters, and the fluid itself becoming of a pure yellow colour.

The resulting lead-precipitate was decomposed by heating it with dilute sulphuric acid; the mixture of sulphate of protoxide of lead, and colouring matters, was then washed with water and exhausted with alcohol, which left the sulphate (coloured by a dark-brown substance), the colouring matters being obtained in solution. With

(1) Ann. Ch. Pharm. LXVI, 351.

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regard to these colouring matters, Debus has given a detailed description of those which are precipitable from the alcoholic solution by ignited protoxide of zinc, reserving for a later communication the account of those that do not exhibit this behaviour.

The alcoholic solution was agitated with small quantities of protoxide of zinc, as long as the latter was coloured red, and the compound of zinc (which deposited better at the boiling temperature) decomposed by dilute sulphuric acid. The colouring matters deposited were partially soluble in ether, a brown resinous substance remaining undissolved. (Boiling alcohol extracted from the latter a brown body, the composition of which is expressed by $C_{60} H_{33} O_{20}$). The ethereal solution was precipitated by protoxide of zinc; in this treatment, a fatty substance, as yet impure, was retained in solution. The zinc-compound was again decomposed by sulphuric acid, and the colouring matters, previously washed, were boiled with a strong solution of alum, as long as anything separated from the latter, after standing for some time. The first solutions deposited a brown-red compound, the last a pure yellow substance. The alumina was extracted from the latter by boiling it with dilute hydrochloric acid, and the residual colouring matter purified by repeated recrystallization from alcohol; Debus has given to it the name *lizaric acid*. The alum-solutions, which had yielded the red-brown, or yellow deposits, were coloured dark-red by a colouring matter which separated only gradually from the solution, on addition of some sulphuric acid; it was boiled with dilute hydrochloric acid, washed with water, and recrystallized from alcohol; Debus has called it *oxylizaric acid*.

The yellow liquid remaining, after treatment of the aqueous decoction with hydrate of protoxide of lead, yielded, when concentrated to syrupy consistence, and mixed with alcohol, an abundant grey precipitate, containing a quantity of colouring matter, and the lead-salt of an acid (which retained the colouring matter persistently, and gave a precipitate with acetate of lead). The alcohol retained sugar, and a yellow substance (having, when purified as far as possible, the composition $C_{30} H_{14} O_{11}$), the solution of which, in hydrochloric acid, became green on boiling, and deposited dark-green flakes, insoluble in water and alcohol; it was coloured red by potassa, and green again by acids.—The aqueous extract of the root was found to contain a large quantity of sulphate of lime, besides sulphate of potassa, phosphate of lime, chloride of potassium, silicic acid, and alumina.

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Lizaric acid(1) crystallizes, by the slow evaporation of its alcoholic solution, in large, light-crimson needles, freely soluble in ether and alcohol, more easily soluble in hot than cold water, and only with difficulty in a boiling solution of alum; it dissolves in concentrated sulphuric acid, with a blood-red colour, and is reprecipitated unchanged by water. It fuses when heated, and sublimes in reddish-yellow needles. When dried at 120°, it has the formula $C_{30} H_{10} O_9$. Its salts are red, or violet, and, with the exception of the potassa-, soda-, and ammonia-salts, all are insoluble in water and alcohol. An alcoholic solution of lizaric acid, employed in small excess, and slightly acidified with acetic acid, gives, with an alcoholic solution of acetate of protoxide of lead, an abundant, beautifully violet precipitate, insoluble in water, but soluble in excess of potassa, or acetic acid, and having, when dried at 120°, the composition $2\,PbO, C_{30} H_8 O_7$.

Oxylizaric acid is distinguished from the preceding substance, by its ready solubility in a solution of alum; it dissolves with difficulty in cold, but more easily in boiling water, is readily soluble in ether, alcohol, and the alkalies; it is dissolved, without change, by fuming, and even warm sulphuric acid. The formula of this acid, dried at 120°, is $C_{15} H_5 O_5$. Its salts comport themselves like the lizarates; the lead-salt, prepared like the lizarate of protoxide of lead, and dried at 120°, is $PbO, C_{15} H_4 O_4$.—Debus did not succeed in the artificial conversion of lizaric into oxylizaric acid.

The greater dyeing power of the madder-root, after treatment with sulphuric acid, is ascribed also by Debus to a portion of the colouring matter being rendered soluble by this process.—This chemist does not confirm Kuhlmann's statement, that malic acid exists in the aqueous extract of madder.

Colouring Matters of Sandal-wood.—The red, resinous, colouring matter, santalin, contained in sandal-wood, had been investigated by Pelletier(2), who assigned to it the formula $C_{16} H_8 O_3$. Preisser had stated (comp. II. p. 61) also of this substance, that it could be obtained colourless, which has been contradicted by Bolley(3). The latter found the substance, precipitated by water from the alcoholic extract of a light-coloured sandal-wood, to contain 67·2 per cent of carbon, and 5·7 to 6·0 of hydrogen; a substance, obtained from a dark sandal-wood, contained 65·3 to 66·2 carbon, and 5·4 to

(1) The editors of the Ann. Ch. Pharm., consider (in a note to this communication) Debus' lizaric acid, and Schunck's alizarin (comp. II. p. 81) as identical.

(2) Ann. Ch. Phys. [2] LI, 193.

(3) Ann. Ch. Pharm. LXII, 150; J. Pr. Chem. XLIII, 510 (in abstr.)

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5·6 of hydrogen; lastly a substance, obtained from the light-coloured wood, by extraction with dilute potassa, precipitation with hydrochloric acid, solution of the precipitate in alcohol, and reprecipitation with water, yielded, on analysis, 64·3 to 64·7 per cent of carbon, and 4·9 to 5·3 of hydrogen. He believes the darker sort to contain a more highly oxidized colouring matter, and oxidation to ensue, likewise, on treatment with potassa. The alcoholic solution of the colouring matter gave, with an alcoholic solution of neutral acetate of protoxide of lead, precipitates, containing varying amounts of protoxide of lead; in one of these compounds, containing 31·8 per cent of protoxide of lead, the amount of carbon found was 62·8, and the hydrogen 4·7 per cent. The relation, existing between these substances of different composition, appears to be, that those, which are poorer in carbon, contain, in the place of hydrogen, an equivalent amount of oxygen. Pelletier's statement, that the colouring matter, when dissolved in ether, appeared to have some action on the latter, has not been confirmed by Bolley.

L. Meier(1) has published researches on sandal-wood, in which he communicates the following results obtained by him. The principal red colouring matter in sandal-wood is a resinous acid, *santalic acid*, besides which it contains *santalic oxide*, and also *santalide*, *santaloide*, *santalidide*, and *santaloidide*; the latter are all neutral substances.—*Santalic acid* is obtained by exhausting sandal-wood with ether or alcohol, and evaporating. The residue is boiled with water, dissolved in alcohol, and precipitated with an alcoholic solution of neutral acetate of protoxide of lead; the precipitate is treated with boiling alcohol, and decomposed by heating with some alcohol and dilute sulphuric acid, and the resulting blood-red solution evaporated. Santalic acid is possessed of a fine red colour; it dissolves in all proportions in absolute alcohol, and is less soluble in alcohol containing water, yielding a blood-red solution, which reddens litmus distinctly; it yields with ether a yellow solution, which does not redden litmus-paper; it crystallizes from its solutions in microscopic prisms; the alcoholic solution is rendered turbid by water, and coloured violet by the alkalies. The acid is insoluble in water, but easily soluble in warm acetic acid; it fuses at 104°, and leaves, on being burnt, an ash, consisting of carbonate and sulphate of lime. Santalic acid dissolves in cold concentrated sulphuric acid, from which solution it is precipitated unaltered by water; if the sulphuric acid solution has been heated, water precipitates from it a black,

(1) Arch. Pharm. [2] LV, 285; LVI, 41; Chem. Gaz. 1849, 130 (in abstr.)

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amorphous mass, containing, together with unaltered santalic acid, a black substance, insoluble in alcohol and ether. Santalic acid completely neutralizes the alkalies. The potassa- and soda-salts are amorphous violet compounds, soluble in water; the whole of the ammonia is expelled from the ammonia-salt by evaporation. The santalates of the alkaline earths and the heavier metallic oxides are mostly violet pulverulent precipitates, of which only the baryta- and lime-salts are soluble; the salt of protoxide of silver is brown.

For the preparation of *santalic oxide*, the alcoholic liquid, from which the santalic acid has been precipitated by acetate of protoxide of lead (as above described) is evaporated, the violet residue exhausted with boiling alcohol (which leaves santalate of lead undissolved), and the yellow solution freed from lead by hydrosulphuric acid and evaporated; the resulting reddish-yellow residue is washed with boiling water and then dissolved in alcohol, the resulting solution is mixed with some potassa (which changes the yellow colour to brown), evaporated, and exhausted with boiling water. The santalic oxide is thus obtained as a brown amorphous mass, easily soluble in alcohol (yielding a brown solution), only slightly so in boiling ether, and insoluble in water. Its solution is not affected by alkalies or salts. Acids change the brown colour immediately to reddish-yellow, and a residue of that colour is obtained on evaporation, in which, after the excess of acid has been removed by washing with water, chemically combined acid may be detected; the compound with nitric acid crystallizes in small granular crystals; those with tartaric, oxalic, or hydrochloric acids are not crystallizable; these compounds are all soluble in ether and alcohol, and insoluble in water; brown santalic oxide is precipitated from their solutions by potassa or soda.

Santalide is obtained from an aqueous decoction of sandal-wood, by precipitating it with acetate of protoxide of lead, washing the red-brown precipitate with cold water, suspending it in alcohol and decomposing it by hydrosulphuric acid; the red-brown filtered liquid is evaporated and the residue exhausted with ether and the ether washed with water, to remove santalidide. The santalide remains as an amorphous dark-red mass, insoluble in water, but dissolving with a red colour in alcohol and ether; its solution gives, with neutral acetate of protoxide of lead, a chocolate-coloured precipitate; the red colour of the solution is not altered by acids, but is changed to a brown by alkalies.—To purify the *santalidide* contained in the wash-waters mentioned above, it is precipitated by neutral acetate of protoxide of lead, and the precipitate decomposed by hydro-

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sulphuric acid; on evaporating the resulting solution, santalidide is obtained as a brown amorphous mass, insoluble in alcohol and ether, but easily soluble in water, with a brown colour.—If the aqueous decoction of sandal-wood be boiled with carbonate of lead, the resulting yellow solution evaporated and the residue exhausted with alcohol, the alcoholic solution evaporated and the yellow residue treated with cold water, *santaloide* is dissolved, and *santaloidide* remains behind; the former is a yellow infusible substance, insoluble in ether; the latter a soft, dark-brown, amorphous, fusible mass.—L. Meier found sandal-wood to contain, in addition to the above substances, gum and gallic acid; the ash contains chloride of calcium, sulphate of lime, chloride of potassium, carbonate of potassa, phosphate of magnesia, alumina, sesquioxide of iron and silicic acid.

Harmala-Red.—Fritzsche(1) has made some communications on the conversion of the seeds of *Peganum harmala* into a red colouring matter. If the powdered seeds be well moistened with alcohol, in a closed vessel, and allowed to stand, they assume, in about eight days, a dark-red colour, which is rendered purer and brighter by addition of fresh quantities of alcohol; the alcoholic odour disappears as the red colouring matter is formed; this reaction is, however, not attended by the absorption of oxygen. The colouring matter is precipitated from its solutions in acids, as a purple, flocculent, almost gelatinous substance, difficultly soluble in water; when dried, it is opaque, dark coloured, and of a greenish lustre; if once more dissolved, it is reprecipitated yellowish-red.

Colouring Matters of various Plants.—Legrip(2) has published some experiments, as precursors of a more detailed investigation, on the colouring matter in the red leaves of *Vitis hederacea* (*Hedera quinquefolia*), in the green leaves of *Vinis vinifera* and in the flowers of the dahlia.—The commencement of an investigation on the red colouration of leaves in general in autumn, and more particularly on the colouring matter in the red leaves of *Vitis hederacea*, has likewise been published by Wittstein(3), who intends continuing his researches on this subject. We shall report on these investigations when they are completed.

Reinsch(4) has examined the reactions of the colouring matter con-

(1) Petersb. Acad. Bull. VI, 300; J. Pr. Chem. XLIII, 155.

(2) J. Chim. Méd. [3] III, 188. Malapert's Reclamations, on account of a likewise uncompleted investigation, J. Chim. Méd. [3] III, 237.

(3) Repert. Pharm. [2] XLVI, 317.

(4) Jahrb. Pr. Pharm. XIV, 100.

tained in a new species of potato and of that contained in the berries of *Ligustrum vulgare*(1); he has also found a crystalline bitter principle in the bark of the latter shrub. Colouring matters of various plants.

Braconnot(2) is of opinion that the colouring matter contained in pumpkins, asparagus-berries, *Solanum dulcamarum*, and in carrots, is identical with, or at least very similar to, the orlean (found as yet exclusively in *Bixa orellana*).

On vegetal colouring matters, compare also Vegetal Chemistry.

Colouring Principle of Cochineal.—Cochineal (*Coccus cacti*) was first submitted to chemical examination by John, afterwards by Pelletier and Caventou in 1818, by Pelletier alone in 1832, and at a later period by Preisser and Arppe. Of the results obtained by these chemists, we shall only mention here, that Pelletier and Caventou gave the most accurate characterization of the colouring principle, which they called *carmin*, although they never obtained it in a state of purity; they did not arrive at its true composition. Preisser's statements, according to which the colouring principle of cochineal would be analogous to that of indigo, have been submitted to an examination by Arppe(3), who found them to have as little foundation as the communications of the same chemist on a series of other colouring matters (comp. II. p. 61). Arppe likewise was unsuccessful in his endeavours to obtain the pure colouring principle of cochineal.

Warren De La Rue(4) has taken up this subject with better success. We abstract the following from his memoir, the result of numerous experiments made on an extensive scale.

Warren De La Rue had the opportunity of submitting the living insect to microscopical examination. He found it to be covered with a white dust, which was likewise observed on the adjacent parts of the cactus-leaves on which the insect feeds. This dust, which he considers as the excrement of the animal, has, under the microscope, the appearance of white curved cylinders, of very uniform diameter. On removing the powder with ether, and piercing the side of the insect, a purplish-red fluid exudes, which contains the colouring matter in minute granules, assembled round a colourless nucleus. These groups float in a colourless fluid, which seems to prove that,

(1) Jahrb. Pr. Pharm. XVI, 389.
(2) Ann. Ch. Phys. [3] XX, 357; J. Pr. Chem. XLI, 471.
(3) Ann. Ch. Pharm. LV, 101.
(4) Chem. Soc. Mem. III, 454; Phil. Mag. [3] XXXI, 471; Ann. Ch. Pharm. LXIV, 1; J. Pharm. [3] XIII, 386, (in abstr.).

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whatever may be the function of the colouring matter, it has a distinct and marked form, and does not pervade as a mere tint, the fluid portion of the insect.

The following is the best method of obtaining, in a state of purity, the colouring principle of cochineal, which Warren De La Rue calls *carminic acid.* The ground cochineal is boiled for about 20 minutes with 50 times its weight of water; the strained decoction, after being allowed to subside for a quarter of an hour, is decanted off and precipitated with a solution of acetate of protoxide of lead, acidulated with acetic acid (1 acid to 6 of the salt). The washed precipitate is decomposed by hydrosulphuric acid, the colouring matter precipitated a second time with acidulated acetate of protoxide of lead and decomposed as before. The solution of carminic acid thus obtained, is evaporated to dryness, dissolved in boiling absolute alcohol, digested with a portion of carminate of protoxide of lead, which has been reserved (for the separation of the phosphoric acid), and then mixed with ether, to precipitate a small portion of nitrogenous matter. The filtrate yields, upon evaporation *in vacuo*, pure carminic acid.—When thus prepared, it is a purple-brown friable mass, transparent when viewed by the microscope, and pulverizable to a fine-red powder, soluble in water and alcohol in all proportions, and very slightly soluble in ether, which does not, however, precipitate it from its alcoholic solution. It decomposes at temperatures above 136°. The aqueous solution has a feebly acid reaction, and does not absorb oxygen from the air; alkalies change its colour to purple, in the alcoholic tincture they produce purple precipitates; the alkaline earths likewise produce purple precipitates. Alum gives with the acid a beautiful crimson lake, but only upon addition of a little ammonia. The acetates of the protoxides of lead, copper, zinc and silver, give purple precipitates; the latter is immediately decomposed, and silver deposited; protochloride and bichloride of tin give no precipitates, but change the colour to a deep crimson. The analyses of carminic acid led to the formula $C_{28}\,H_{14}\,O_{16}$; the compound of protoxide of copper appeared to be the only salt that could be employed with any certainty for the determination of the atomic weight, as the other salts furnished no satisfactory results. The salt of copper was prepared by cautiously adding to an aqueous solution of carminic acid, acidulated with acetic acid, acetate of protoxide of copper, so as to leave an excess of carminic acid in the liquid. When dried, it is a bronze-coloured hard mass; analysis led to the formula $CuO,\,C_{28}\,H_{14}\,O_{16}$.

If 1 part of carminic acid be added gradually to 6—7 parts of

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nitric acid, spec. grav. 1·4, moderately heated, and the liquid be exposed, after the evolution of nitrous fumes has ceased, to a boiling temperature for a few hours, it solidifies, after evaporation of the excess of acid, to a crystalline mass, which contains, besides oxalic acid, a new acid, called by Warren De La Rue *nitrococcussic acid.* To separate the oxalic acid, the hot aqueous solution is precipitated with nitrate of protoxide of lead, and the filtered liquid evaporated, when nitrococcussic acid is deposited finally in yellow rhombic prisms. Recrystallization renders it pure. It is soluble in water, alcohol and ether; its solutions stain the skin yellow. It dissolves iron and zinc, becoming dark-coloured, and is decomposed by sulphide of ammonium, with the formation of a new acid, which has not yet been examined. The salts of nitrococcussic acid are all very soluble in water, and detonate when heated. The analysis of the acid, dried at 100°, led to the formula $C_{16}\,H_5\,N_3\,O_{18}$. When crystallized from water, it contains 2 equivs. of water of crystallization. Nitrococcussic acid is bibasic; salts containing 1 eq. of the oxide of a metal could not be obtained. Warren De La Rue has analysed the following:

Potassa-salt . .	$2\,KO,\quad C_{16}\,H_3\,N_3\,O_{16}$.
Ammonia-salt .	$2\,NH_4\,O,\ C_{16}\,H_3\,N_3\,O_{16} + HO$.
Baryta-salt . .	$2\,BaO,\quad C_{16}\,H_3\,N_3\,O_{16} + 2HO$.
Silver-salt . . .	$2\,AgO,\quad C_{16}\,H_3\,N_3\,O_{16}$.

If protoxide of silver be treated with a hot aqueous solution of nitrococcussic acid, decomposition ensues, carbonic acid is evolved in large quantities, and the liquid contains a new acid, crystallizable in needles, which has not yet been farther investigated.—Nitrococcussic acid exhibits a great analogy to styphnic and picric acids.

The mother-liquor, from which the carminic acid had been obtained, yielded, upon concentration, after the separation of the excess of protoxide of lead by hydrosulphuric acid, a white crystalline body, which was obtained in silky crystalline tufts by washing with cold water and repeated recrystallization from hot water with animal charcoal. This substance exhibits, according to Warren De La Rue, so much similarity to tyrosin which Liebig obtained by fusing caseïn with potassa, that he is inclined to consider these two bodies as identical. Liebig assigns to tyrosin the formula $C_{16}\,H_9\,N\,O_5$, which requires 60·4 per cent of carbon and 5·6 per cent of hydrogen. Warren De La Rue proposes for the above-mentioned body the formula $C_{18}\,H_{11}\,N\,O_6$ (not supported, however, by the determination of its atomic weight); this formula requires 59·7 per cent of carbon,

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6·1 of hydrogen and 7·7of nitrogen ; the mean of the analytical results are 59·4, 6·3, 7·7. Farther examination of both bodies must decide whether they be in reality identical. Warren De La Rue convinced himself that this substance exists ready formed in cochineal. It is soluble in alkalies and acids, without entering into combination with them ; nitric acid decomposes it easily, with the formation of new products.

Comparative experiments on the dyeing power of cochineal reared in Algiers and the Mexican cochineal, have been instituted by Chevreul (1)

Sugar, Starch, Woody Fibre, Pectin, and their Correlatives. Sugar.—Dubrunfaut(2) has made some investigations on the changes which cane-sugar undergoes during fermentation, and by which, previously to the formation of alcohol and carbonic acid, it is converted into a kind of sugar resembling grape-sugar. The results of his experiments led him to the following conclusions. The metamorphosed sugar, as likewise the analogous grape-sugar or fruit-syrup, is not chemically a simple variety of sugar ; it does not become grape-sugar (*glucose*) by crystallization, only a certain quantity of grape-sugar being separated, and the property possessed by the residuary liquor of deflecting the plane of polarization towards the left is increased to an amount equal to the power possessed by the separated grape-sugar of deflecting in the inverse direction. By various methods the metamorphosed sugar can be converted into an amorphous saccharine substance, possessing amongst other characteristics, a faculty of deflecting at a temperature of 14^0 towards the left, with a force treble that of the metamorphosed sugar at the same temperature. The phenomena exhibited by the vinous fermentation of metamorphosed sugar likewise prove that it is not chemically a simple sugar, inasmuch as the sugar which disappears at the commencement of the process is optically neutral, whilst the portion which disappears at the conclusion, namely the uncrystallizable variety just mentioned, possesses a strong deflecting power towards the left. The same deportment is exhibited during lactic fermentation, the grape-sugar, however, which is contained in the metamorphosed sugar is

(1) Compt. Rend. XXVI, 375.
(2) Ann. Ch. Phys. [3] XXI, 169 ; J. Pr. Chem. XLII, 418.

in this case the first which decomposes. At no time in the fermentation of mere mixtures of different kinds of sugar, is one sugar decomposed exclusively before the other. Sugar.

Dubrunfaut(1) has farther stated, that the sugar produced from starch by the action of malt is by no means identical with grape-sugar. The crystalline habitus, it is true, is the same in both kinds, but the former is somewhat less soluble in alcohol than the latter, and less liable to be altered by ebullition with water and alkaline liquids; the optical deflecting power of the former is three times as great as that of the latter, and is not altered by the solution being allowed to stand for some time. The former variety of sugar is converted into grape-sugar when boiled for a sufficient time with dilute sulphuric acid; it is formed both by the action of acids and of nitrogenous substances on starch. The optical deflecting power of such quantities of grape-sugar kept in solution for a long period, of grape-sugar freshly dissolved, of the saccharine substance just mentioned, and of dextrin, as will afford by fermentation the same amount of alcohol, are in the ratio of 1 : 2 : 3 : 4.

Mannite.—Ruspini(2) gives the following method for preparing mannite. Manna (an inferior kind may be advantageously employed) is dissolved in half its weight of rain-water, clarified with white of egg, and strained, while boiling-hot, through a flannel bag; the resulting crystalline mass is converted into a paste, allowed to drain, and then pressed, the expressed liquor being concentrated and treated in the same way. The cake of mannite thus obtained is purified by macerating it with cold rain-water to a thick paste, allowing the liquor to run off and dissolving the pressed substance in six or seven times the quantity of hot water, treating with animal charcoal, and filtering whilst hot; the evaporated filtrate is allowed to crystallize.

Reinsch(3) found large quantities of mannite in the so-called honey-dew on lime-leaves; 100 parts of the same contained 53·5 mannite, 16·0 of grape-sugar, 9·2 of gum, 3·4 of a viscid matter, 0·6 of yellow extractive matter, 15·0 of water, 1·0 of insoluble constituents (loss 1·3).

Starch.—Shier(4) has determined the amount of starch contained in several plants growing in British Guiana. Mayet(5) has commu-

(1) Ann. Ch. Phys. [3] XXI, 178; J. Pr. Chem. XLII, 425; Compt. Rend. XXV, 308 (in abstr.)

(2) From the Manuale Eclettico dei Rimedi Nuovi. Bergamo, 1846, in Ann. Ch. Pharm. LXV, 203.

(3) Jahrb. Pr. Pharm. XIV, 153.

(4) J. Pharm. Trans. VII, 590.

(5) J. Pharm. [3] XI, 81.

Starch.

nicated some observations on the action of caustic alkalies on different specimens of starch, with the object of distinguishing the various kinds by the consistence, colour, transparency, &c., of the resulting mass. Respecting the starch of lichens, compare '*Cetraria islandica*.'

Amidulin.—F. Schulze(1) designates as amidulin a modification of starch, which is the connecting link between the true starch and inulin or dextrin; it is distinguished by being easily and entirely soluble in hot water, and is prepared by boiling a mixture of sulphuric acid, water, and starch, ebullition being interrupted as soon as the starch is dissolved. The acid whilst hot is neutralized with carbonate of lime, when flakes of amidulin separate after a short time. Its composition was found to agree with that of starch.

Inulin.—Bouchardat(2) has communicated the following statements concerning inulin. It deflects the plane of polarization towards the left; under the influence of acids, the deflecting power in the same direction is increased; dilute acids convert it in the cold as well as by the aid of heat (without the disengagement or absorption of gas) into a new kind of sugar, which deflects the plane of polarization at least three times more towards the left than does cane-sugar metamorphosed (by ferment ?). The deflecting power of this sugar is diminished by an increase of temperature, but according to a law differing from that of cane-sugar. Unwashed yeast causes inulin to ferment, while washed yeast is without action, the acid necessary for the conversion of inulin into sugar being wanted. Diastase does not change the deflecting power of inulin. The juice of the tubers of dahlias contains nearly 12 per cent of inulin, which is converted into a less soluble modification, even on the exclusion of the air; pure cold water dissolves scarcely 2 per cent of inulin.

Gum.—Riegel(3) found the precipitate produced by basic acetate of lead in a solution of gum arabic to contain from 37·9 to 38·1 per cent of protoxide of lead, agreeing pretty closely with the statement of Mulder regarding the composition of this compound (PbO, $C_{12}H_{10}O_{10}$), but not with the result obtained by Péligot ($2PbO$, $C_{12}H_9O_9$).

Woody Fibre.—Poumarède and Figuier(4) have examined the woody fibre of various plants. They reduced the wood by means of a file to a fine powder, which they placed in contact with a solution of potassa for twenty-four hours; it was then washed with water, with

(1) J. Pr. Chem. XLIV, 178.
(2) Compt. Rend. XXV, 274.
(3) Arch. Pharm. [2] LV, 155.
(4) Loc. cit. II. 100.

dilute hydrochloric acid and subsequently again with water; after having remained in a solution of common salt for some days, it was washed with a weak solution of potassa, with dilute hydrochloric acid, and with water, and finally, after drying, with alcohol and ether, when it was not blackened by concentrated sulphuric acid. Woody fibre from different sources, thus prepared and dried at 120°, they found to be composed of: Woody fibre.

	Poplar.			Beech.	Filtering paper.		Bamboo bark.	Cotton.		Flax.	
Carbon	43.53	43·79	44·32	43·85	43·87	43·84	43·61	43·46	43·10	43·92	43·33
Hydrogen	6·25	6·36	6·08	6·22	6·12	6·22	6·11	6·38	6·43	6·01	6·41
Oxygen	50·22	49·85	49·60	49·93	50·01	49·94	50·28	50·16	50·45	50·07	50·26

If woody fibre be steeped in concentrated sulphuric acid for no longer than half a minute, then washed with a large quantity of water, and afterwards immersed for a few seconds in water, to which a few drops of ammonia have been added, a membranous substance is formed, which Poumarède and Figuier have designated as *papyrin*, and which they ascertained to have the same composition as woody fibre (43·3 to 44·4 carbon, 6·2 to 6·3 hydrogen, and 49·3 to 50·4 oxygen).

For the changes which cotton-fibre, sugar, mannite and other substances undergo when acted on by nitric acid or nitro-sulphuric acid, we refer to our Report on Technical Chemistry.

Fremy(1) has published a very elaborate treatise on pectin and its correlatives as part of a comprehensive investigation on the ripening of fruit.

(1) Ann. Ch. Phys. [3] XXIV, 5; Ann. Ch. Pharm. LXVII, 257; J. Pr. Chem. XLV, 385; Laurent and Gerhardt's Compt. Rend. des Trav. Chim. 1849, 57 (in abstr.) Some earlier and shorter statements of the results are to be found in the Compt. Rend. XXIV, 1046; J. Pharm. [3] XII, 13; Ann. Ch. Pharm. LXIV, 383; J. Pr. Chem. XLII, 18.—The principal points of the researches preceding Fremy's complete treatise on pectin, may be briefly mentioned here.—Soubeiran (J. Pharm. [3] XI, 417; J. Pr. Chem. XLI, 309) concluded from his researches that pectin is contained in fruits either partly in an undeveloped and soluble state, or in the form of compounds which are decomposable by acids. In support of his opinion he adduced the following facts: that the juice of fruits before maturation contains no pectin in solution, which may, however, be extracted from the pulpy part by boiling with acidified water; but that the juice of ripe fruits contains pectin in solution, which is likewise present to a very considerable extent in the pulp, from which part can be extracted in the cold by acidified water, part only on ebullition. According to the first supposition, the insoluble cellular tissue is gradually converted into soluble pectin; this is effected either slowly by the process of maturation, or rapidly but partially by boiling with water, or more completely by the aid of acids. According to the second hypothesis, pectin is contained in the fruits in the form of a lime-compound; but it cannot be well understood why, in the unripe fruits,

Pectose.

Pectose.—A substance insoluble in water, alcohol and ether, which Fremy calls pectose, is found as an almost constant associate of cellulose in the tissue of plants, and chiefly in the pulp of unripe fruits and certain roots, as carrots, turnips and others. On account of its insolubility, it cannot be separated from the cellulose in an unchanged form, and in consequence of the perfect transparency of both bodies, no decided difference is exhibited by microscopic investigation. Pectose is, however, chemically characterized and materially distinguished from cellulose by its being converted into pectin when subjected to the simultaneous action of heat and dilute acids (with exception of acetic acid); this character decidedly does not belong to cellulose. The conversion of pectose into pectin does not take place in the cold, even if this substance be treated with concentrated hydrochloric acid. The hardness of unripe fruits and roots is caused by the presence of pectose, which likewise occasions the hardening produced by ebullition with lime-water, the lime entering into combination with this substance. Pectose is ultimately transformed into pectin by the boiling or ripening of fruits.

Pectin.—From what has been stated, pectin exists ready formed only in ripe fruits, in which it is produced by the action of malic and citric acids on pectose. Not a trace of pectin can be detected in the juice expressed from the pulp of an unripe apple, but on boiling the juice for some seconds with the pulp, pectin immediately appears, and is indicated by the liquid becoming viscid. When produced in this way, it is, however, obtained only with great difficulty in a state of purity; when precipitated from an aqueous solution by means of alcohol, it often contains dextrin, malate of lime, an albu-

acids do not separate it from this compound, why boiling water takes up some pectin from it, and why acids effect a complete solution only on the application of heat. Baudrimont (J. Pharm. [3] XII, 24) on the contrary, is of opinion that pectin precipitates the lime in fruits only by surface-attraction, without entering into a true chemical combination with it; this view would remove the difficulties raised by Soubeiran against what we have called above the second supposition.—Poumarède and Figuier (Compt. Rend. XXIII, 918; XXV, 17; J. Pharm. [3] XI, 458; XII, 81; Ann. Ch. Pharm. LXIV, 387; J. Pr. Chem. XLII, 25; Repert. Pharm. [2] XLVII, 344) likewise believe that pectin acts in plants less by chemical attraction towards inorganic substances than by its absorptive properties; in the "normal" condition they state that it may contain above 8 per cent of inorganic substances, which are present in it in a peculiar "physiological" state; according to their opinion, pectin is only finely divided cellular tissue, and has the same composition as woody fibre (an assertion which is, however, contradicted by their own experiments). They deny the existence of pectic acid, and state that what hitherto has been taken for it is only pectin, to which some hydrochloric acid adheres.—Fremy (J. Pharm. [3] XII, 174; J. Pr. Chem. XLII, 428) has given a review of these statements.

minous substance, a compound of pectic acid with ammoniacal salts, and, if sulphuric or oxalic acids have been employed in its preparation, true compounds of pectin with these acids.—On this account, Fremy considers the following method to be the only one by which pectin can be obtained pure. From the juice of ripe pears, expressed in the cold, and filtered, the lime is to be separated by means of oxalic acid, and the albuminous substance by the aid of concentrated tannic acid. From this liquid pectin is now precipitated by means of alcohol; it separates in long threads, which after being washed with alcohol, are to be dissolved in water and again precipitated with alcohol. This is to be repeated three or four times, until the liquid is free from sugar and oxalic acid; hot water must be avoided in these operations. If the pectin be pure, it will be precipitated from its solutions so thoroughly by baryta-water, that not a trace of organic matter can be found in the filtrate. Pectin thus prepared is soluble in water, uncrystallizable and precipitable by alcohol, as a jelly from dilute, and in long threads from concentrated solutions. Its solution is neutral. It is precipitated by neutral acetate of lead only, when, as is generally the case, parapectin is mixed with it; basic acetate of lead produces an abundant precipitate.

If it be treated with alkalies or alkaline earths, salts of pectic acid are immediately formed, from which the insoluble acid is separated on the addition of stronger acids. Under the influence of a peculiar ferment, pectase, it is converted into a gelatinous acid, pectosic acid; acids convert it into metapectic acid. According to Fremy, it has the following composition:

	Theory.		Experiment.		
			I.	II.	III.
C_{64}	384	40·67	39·71	39·51	40·54
H_{48}	48	5·08	5·49	5·55	5·47
O_{64}	512	54·25	54·80	54·94	53·99
	944	100·00	100·00	100·00	100·00

Pectin prepared by other methods, and more particularly that obtained from carrots by means of dilute acids, very often forms a jelly with water, whilst a solution of pure pectin is mucilaginous. In the former case it is mixed with a compound of pectic acid with ammoniacal salts, from which it cannot be separated. We shall return to this when speaking of pectic acid.

Parapectin.—The aqueous solution of pectin, by being boiled for some hours, loses its mucilaginous nature and is converted into

Parapectin. *parapectin* which is distinguished from pectin by being precipitated by neutral acetate of lead. Dried at 100° it has, according to Fremy, the same composition as pectin; at 140° it loses 2 eq. of water, which may be partly or entirely replaced by protoxide of lead.

Metapectin.—Parapectin by being boiled with dilute acids, is converted pretty rapidly into *metapectin*, which possesses a decidedly acid character. It reddens litmus, is soluble in water, uncrystallizable, insoluble in alcohol, and yields by being brought in contact with bases, salts of pectic acid. It precipitates chloride of barium, whereby it is distinguished from pectin and parapectin. It is isomeric with these substances, and loses, like the latter, 2 eq. of water at 140°, which may be replaced by 2 eq. of the protoxides of lead and barium. The composition of metapectin is:

	Theory.	Experiment.		
		Dried at 140°.	In the lead-compound.	
			I.	II.
C_{64}	41·48	41·85	41·42	42·17
H_{46}	4·97	5·58	5·60	5·44
O_{62}	53·55	52·57	52·98	52·44
	100·00	100·00	100·00	100·00

The formula $2\,PbO, C_{64} H_{46} O_{62}$ requires 19·4 per cent of protoxide of lead; experiment gave 19·6 and 20·9 per cent. The baryta-compound gave 14·0 and 15·0 per cent of baryta; the theoretical value of the formula $2\,BaO, C_{64} H_{46} O_{62}$, is 14·1 per cent. Metapectin yields with acids, compounds which are soluble in water and precipitable by alcohol.

It is well known that in grapes we find a ferment together with sugar, in bitter almonds synaptase together with amygdalin, and in the malt diastase together with starch; in the same manner we find that a body is present in all plant-tissues containing pectose, which exerts a particular action upon pectose, and which in every respect may be compared with diastase or synaptase; Fremy has, therefore, called this body *pectase*. It is the ferment of these gelatinous substances, and effects the conversion of the pectose into two gelatinous acids, insoluble in water, namely pectosic and pectic acids. This conversion, pectic fermentation, like lactic fermentation, proceeds in the absence of air, without disengagement of gas, and at a temperature of 30°. Pectase occurs in the organism of plants in the soluble and in the insoluble state. In carrots and beet-root it is contained in the soluble form; their juice induces pectic

fermentation. The juice of apples and of other acidulous fruits has no action on pectin; pectase in these fruits is in the insoluble modification, and remains in the insoluble part of the pulp; for if the pulp of an unripe apple be introduced into a solution of pectin, the latter will in a short time become gelatinous, on account of the formation of the acids just mentioned. Pectase may be prepared by precipitating the juice of fresh carrots with alcohol. It then becomes insoluble in water without losing its efficacy; it is decomposed in water after some days, with formation of a mould and the loss of its property as a pectic ferment; the same change takes place on continuous ebullition.

Metapectin.

Pectosic Acid.—If pectase be added to a solution of pectin, the formation of a jelly ensues and pectosic acid is formed. The action of dilute solutions of potassa, soda, ammonia, or carbonate of ammonia on pectin in the cold, gives rise to the formation of salts of pectosic acid. This acid is gelatinous, scarcely soluble in cold and insoluble in acidified water; the solution in boiling water becomes gelatinous on cooling. Boiling water, as likewise an excess of the alkalies, or pectase convert it into pectic acid. Its composition in 100 parts is:

	In the free state.				In the lead-salt.		
		Theory.	Expt.			Theory.	Expt.
C_{32}	192	41·48	41·08	C_{32}	192	43·14	42·91
H_{23}	23	4·97	5·25	H_{21}	21	4·71	5·18
O_{31}	248	53·55	53·67	O_{29}	232	52·15	51·91
	463				445		

The formula of the lead-salt, $2\,PbO, C_{32}\,H_{21}\,O_{29}$, requires 33·4 per cent of oxide; 32·7 per cent was found. In pectosate of baryta $= 2\,BaO, C_{32}\,H_{21}\,O_{29}, HO$, from 24·1 to 24·7 per cent of baryta was found; 25·3 is required by the formula.

Pectic Acid.—According to Fremy, *pectic acid* is produced when a solution of pectin, in which pectase is suspended, is allowed to remain for some time at 30°; the pectin is first converted into pectosic and then into pectic acid. Dilute solutions of caustic and carbonated alkalies, of lime-, baryta- and strontia-water convert pectin immediately into salts of pectic acid, from which the pectic acid can be separated by acids.—Pectic acid is insoluble in cold, and scarcely soluble in boiling water; by continued ebullition it is converted into a new acid, which is soluble in water and deliquescent. Pectic acid, prepared according to the usual method, is invariably mixed with a nitrogenous substance, a fact which was observed by

Pectic acid.

Mulder(1) previously to Fremy, and which renders all earlier analyses doubtful. According to Fremy, this acid can be obtained in a state of purity and perfectly white, by boiling the well-washed pulp of carrots with water slightly acidified with hydrochloric acid, and treating the filtered solution of pectin whilst boiling with an exact quantity of carbonate of soda, when pectate of soda is formed; from this salt the pectic acid is separated by the addition of hydrochloric acid, and subsequently washed with water. An excess of carbonate of soda produces metapectic acid, and an insufficient quantity of the same pectosic acid, both of which are soluble in water.

Salts of pectic acid with a definite amount of oxide can be prepared only with the greatest difficulty, as many salts, almost all the ammonia-salts of organic acids, and particularly the pectates, possess the faculty of dissolving considerable quantities of pectic acid. Pectate of ammonia, with an excess of base, produces in a solution of acetate of lead, precipitates, in which the quantity of oxide varies between 34 and 60 per cent, according to the amount of ammonia contained in the salt. Fremy obtained a baryta-salt, of constant composition, by treating a solution of pectin in the cold, with exclusion of air, with a great excess of baryta-water. At first a precipitate of pectosate of baryta is formed, which soon passes into the pectate; it must be rapidly washed and dried, first *in vacuo*, and then at 120°. The composition of pectic acid was found to be:

	Hydrate.					In the lead- and barium-salt.			
	Theory.		Experiment.				Theory.		Expt.
C_{32}	192	42·29	41·35	41·55	41·30	C_{32}	192	44·03	43·91
H_{22}	22	4·84	4·56	4·75	5·02	H_{20}	20	4·58	4·87
O_{30}	240	52·87	54·09	53·70	53·68	O_{28}	224	51·39	51·22
	454	100·00	100·00	100·00	100·00		436	100·00	100·00

Fremy adopts the formula $2\,MO,\ C_{32}\ H_{20}\ O_{28}$ for the lead- and barium-salts. The analysis of the lead-compound gave 35·0, 33·1 and 32·7 (calculated 33.8) per cent of protoxide of lead; that of the barium-compound 26·8, 26·4, 25·7 and 25·3 (calculated 26·0) per cent of baryta.—Fremy states that he obtained the same results with pectic acid, prepared by different methods from carrots, turnips, apples, pears and gooseberries.

Fremy explains the behaviour of pectic acid towards salts,

(1) Scheik. Onderzoek. III, 17; Berzelius' Jahresber. XXVI, 611.

Pectic acid.

(*v. supra*), in the following manner. If a liquid in which pectic acid is suspended be mixed with a small quantity of an alkaline salt, and especially with the ammonia-salt of citric, malic or oxalic acid, the pectic acid will be immediately dissolved on the application of heat, while double salts are formed, which may easily be mistaken for pectin; these double compounds are soluble in water in the presence of an excess of the salt, but lose their solubility by repeated precipitation with alcohol. They have an acid reaction and dissolve in boiling water, the solutions becoming gelatinous on cooling. The same compounds can be formed during the preparation of pectin, when they will impart to it the faculty of gelatinizing. The well-washed pulp of carrots contains cellulose, pectose, pectate of lime and other lime-salts, more particularly phosphate of lime and phosphate of magnesia-ammonia. The acid employed in the preparation of pectin decomposes the pectate of lime, separates pectic acid, and induces moreover, by the decomposition of the lime- and magnesia-salts, the formation of ammonia-compounds, which cause the dissolution of the pectic acid, whereby, together with pectin, gelatinous substances enter into solution. The formation of these double salts may be avoided by digesting the pulp for twenty-four hours in cold water, strongly acidified with hydrochloric acid, which dissolves the lime- and the magnesia-salts, while the pectose is not perceptibly changed; by now washing the pulp with pure water, and then boiling it with water feebly acidified, pectin is obtained in a state of perfect purity.

Parapectic Acid.—By boiling pectic acid in water for a long time, *parapectic acid* is formed; the salts of pectic acid are likewise converted into parapectates when exposed to a temperature of 150°, or when boiled for some hours. Parapectic acid is not crystallizable, it has a decidedly acid reaction, and forms soluble salts with the alkalies; it is precipitated by an excess of baryta-water. It was analysed only in the lead-salt. We append two analyses of the salt, dried at various temperatures:

I. The lead-salt dried at 110°.

		Theory.	Expt.
C_{24}	144	41·76	41·79
H_{17}	17	4·93	4·93
O_{23}	184	53·31	53·28
	345	100·00	100·00

II. The lead-salt dried at 150°.

		Theory.	Expt.
C_{24}	144	44·04	44·40
H_{15}	15	4·58	4·88
O_{21}	168	51·38	50·72
	327	100·00	100·00

Parapectate of lead, when dried at 110°, has the formula $2\,PbO$, $C_{24}\,H_{15}\,O_{21}$, $2\,HO$, at 150° $2\,PbO$, $C_{24}\,H_{15}\,O_{21}$; (experiment 40·0, 40·7, and 41·3 per cent of protoxide of lead; theory 40·5 per cent).

Parapectic acid. —A potassa-salt, prepared by neutralizing the acid with potassa and precipitating with alcohol, gave 23 per cent of potassa, the formula 2 KO, C_{24} H_{15} O_{21} requires 22·3 per cent.

Metapectic Acid.—*Metapectic acid* is formed by allowing a solution of pectin to remain for some days, by the action of strong acids on pectin, or of an excess of alkali on pectin, pectosic and pectic acids. Pectic acid, when left in an aqueous solution for from two to three months, will dissolve, being changed into metapectic acid, (a residue remaining, consists of albuminous substances, which are almost always present); dilute acids or the application of heat effect the conversion in 36 hours. Parapectic acid in an aqueous solution is rapidly changed into metapectic acid.

Metapectic acid is soluble in water, uncrystallizable, and forms soluble salts with all bases; it is precipitated only by the basic acetate of lead. Its solution soon becomes mouldy; when boiled for a long time, it yields acetic acid and a black substance, resembling ulmic acid. Both para- and metapectic acids (like sugar) decompose boiling solutions of the double tartrate of copper and potassa, but neither exert any action on polarized light, nor ferment with yeast, which proves that they contain no sugar. Metapectic acid in the lead-salt dried at 160°, has the following composition:

		Theory.	Experiment.		
C_8	48	44·04	43·77	43·00	43·77
H_5	5	4·58	4·38	4·98	4·38
O_7	56	51·38	51·85	52·02	51·85

It has the same percentage-composition as parapectic acid, but its equivalent is three times less. By precipitation with basic acetate of lead, metapectic acid produces compounds, having the formula 2 PbO, C_8 H_5 O_7 (67·2 per cent of protoxide of lead), or 3 PbO, C_8 H_5 O_7 (75·4 per cent); Fremy obtained from 67·5 to 68·8 and from 73·4 to 74·2 per cent of protoxide of lead.

Metapectic acid exhibits in its composition a relation to malic acid, similar to that which is known to exist between several other organic acids; for instance between chelidonic and meconic acids.

Metapectic acid	C_8 H_5 O_7	Chelidonic acid	C_{14} H_5 O_{13}
Anhydrous malic acid	C_8 H_4 O_8	Meconic acid	C_{14} H_4 O_{14}

Pyropectic Acid.—If pectin or one of its derivatives be heated to 200°, water and carbonic acid are given off, whilst a black acid, insoluble in water, is left behind, which Fremy calls *pyropectic acid.*

It is soluble in alkaline liquids, and forms brown amorphous salts. Its composition was found to be : Pyropectic acid.

	Theory.		Experiment.
C_{14}	84	50·96	51·32
H_9	9	5·46	5·33
O_9	72	43·58	43·35
	165	100·00	100·00

The equivalent of the acid was not determined; its formation is explained by the following equation :

$$2\,(C_8\,H_5\,O_7) = C_{14}\,H_9\,O_9 + HO + 2\,CO_2.$$

Fremy gives the following synoptical table, exhibiting the composition of the pectin-bodies and the lead-salts which he examined.

	Formula.	Lead-compound.	PbO in 100 parts.
Pectose	—	—	—
Pectin	8 HO, $C_{64}\,H_{40}\,O_{56}$	—	—
Parapectin	8 HO, $C_{64}\,H_{40}\,O_{56}$	7 HO, PbO, $C_{64}\,H_{40}\,O_{56}$	10·6
Metapectin	8 HO, $C_{64}\,H_{40}\,O_{56}$	6 HO, 2 PbO, $C_{64}\,H_{40}\,O_{56}$	19·4
Pectosic acid	3 HO, $C_{32}\,H_{20}\,O_{28}$	HO, 2 PbO, $C_{32}\,H_{20}\,O_{28}$	33·4
Pectic acid	2 HO, $C_{32}\,H_{20}\,O_{28}$	2 PbO, $C_{32}\,H_{20}\,O_{28}$	33·8
Parapectic acid	2 HO, $C_{24}\,H_{15}\,O_{21}$	2 PbO, $C_{24}\,H_{15}\,O_{21}$	40·5
Metapectic acid	2 HO, $C_8\,H_5\,O_7$	2 PbO, $C_8\,H_5\,O_7$	67·2

All the bodies derived from pectin possess an acid character, which becomes more and more decided in proportion as the equivalent diminishes. The series commences with neutral pectin and terminates with a strong acid. All the members of this group are isomeric or differ from one another only by the elements of water; in this respect they resemble starch and woody fibre, which in their decompositions, particularly under the influence of fermentative processes, pass through a series of isomeric conditions, giving ultimately rise to the formation of lactic acid, which is likewise isomeric with starch.

On carefully examining Fremy's beautiful investigation, we readily perceive that the conception of such relations existing between the pectin-bodies, which is certainly not far from the truth, has influenced the interpretation of his analytical results to a greater extent than is generally admissible in chemical researches of another nature; but he justly remarks, that the analysis of uncrystallizable bodies which are so easily transformed into each other, by the action of bases, acids, and even water, present difficulties which must excuse the discrepancies of theory and experiment.

Fremy is decidedly opposed to the view of pectin being isomeric

Pyropectic acid.

with woody fibre. The faculty possessed by pectin whilst in the presence of pectase in close vessels, of passing through all the phases of the pectin-bodies down to metapectic acid, without the formation of other products, certainly shows that the sole agent in these metamorphoses are water or its elements, excluding the action of free oxygen, as Chodnew had inferred from his researches. Fremy was unable to detect the formation of any sugar; if it actually occurred, he is inclined to attribute it to the presence of starch, which is often found in impure pectin.

Ripening of Fruits.—According to Fremy, the metamorphoses which the pectin-bodies undergo during the process of ripening, are exactly the same as those produced, in his researches, by acids, by water, by alkalies, or by pectase. Unripe fruits contain no pectin, but pectose, the latter is converted into pectin and parapectin, as the fruit gradually ripening loses its hardness, by the action of the acids present; if the fruit be over-ripe, even the latter two have disappeared, having, by the aid of the pectase, been transformed into metapectic acid, which combines with potassa or with lime. Beet-root and cane-sugar-molasses likewise contain metapectic acid. This acid ultimately induces, like other organic acids, the conversion of starch into sugar.—By boiling fruits, the formation of pectin proceeds in the same manner as in the process of maturation, the presence of acids being a necessary condition; the formation of a jelly, which occurs after some time, arises from the transformation of the pectin into pectic or pectosic acids, which is induced by the presence of pectase, or it is due to the solution of pectic acid in the salts of organic acids. The juice of gooseberries sometimes rapidly gelatinizes when mixed with the juice of raspberries; the latter is rich in pectase, which converts the pectin of the former into gelatinous pectosic acid.

Ulmin-like Substance.—A black, ulmin-like substance, which floated on the surface of Loch Dochart, in Scotland, after an earthquake, and which was probably decayed turf, was found by Gregory(1) to consist of 76·7 carbon, 4·7 hydrogen, and 18·6 per cent oxygen, a very insignificant quantity of ash, and only traces of nitrogen.

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(1) Ann. Ch. Pharm. LXI, 365.

Peculiar Vegetal Substances.—Lebourdais(1) in a treatise on the constituents of plants *(principes immédiats)*, proposes to use, for the preparation of these bodies, the property possessed by animal charcoal (which had been observed by various other chemists—Waringtón, Weppen, &c.), of precipitating the bitter substances and the other principles of plants from their solution. The aqueous solution of the plant is to be boiled with bone-black freed from all its salts by hydrochloric acid, until the liquor has become colourless and is no longer of a bitter taste; the charcoal is then to be washed with water, and after drying, extracted with boiling alcohol. The latter extracts the bitter principle or the organic base, which remains in a pure state after the evaporation of the alcohol. The aqueous extract of plants, before treatment with animal charcoal, may also be freed by lead-salts from such substances as are precipitable by these reagents.

Lebourdais states, that he has prepared in this way colourless syrupy ilicin, scillitin, arnicin and colocynthin; some others, as digitaline, columbine, &c., were obtained in a crystallized state. Although these researches, as would appear from their description, have not been conducted with that amount of circumspection which would entitle them to entire confidence, still they show that this deportment of animal charcoal, when used as a decolourizing agent, deserves more attention than has hitherto been paid to it.

Gentianin.—Baumert(2) has subjected gentianin to a new investigation. In order to obtain it pure, he tried to avail himself of its property of being precipitated only by the basic acetate of lead, and not by the neutral acetate; he was, however, unsuccessful, which induced him to return to the method indicated by Leconte(3). 20 lbs. of dry gentian-root yielded scarcely 1 drachm of pure gentianin. He found pure gentianin, freed from all bitter principles, and crystallized in delicate, pale-yellow needles, to be tasteless; it dissolves at 16^0 in 3630 times its weight of water, more easily in ether, and most readily in boiling alcohol. In the alkalies it dissolves easily, with a golden-yellow colour. When heated to 200^0 it loses its lustre and becomes brown, without, however, parting with water; between 300^0 and 400^0 it partly sublimes, whilst the greatest portion remains behind, as a

(1) Ann. Ch. Phys. [3] XXIV, 58; J. Chim. Méd. [3] V, 4; J. Pr. Chem. XLV, 363; Ann. Ch. Pharm. LXVII, 251.

(2) Ann. Ch. Pharm. LXII, 106; Repert. Pharm. [2] XLVII, 225; J. Pharm. [3] XIII, 51.

(3) Ann. Ch. Pharm. XXIII, 370; Berzelius' Jahresber. XVIII, 392.

Gentianin.

charred mass. Its composition was found to be represented by the formula $C_{14}\ H_5\ O_5$. Its compounds with soda crystallize in golden-yellow needles, with or without water of crystallization; (in the former case they effloresce in the air; their water of crystallization is evolved at 100°). These compounds have an alkaline reaction, and are readily decomposed by acids, even by carbonic acid, and likewise by much water, or the continued action of alcohol. From a solution which was prepared by boiling gentianin with carbonate of soda in alcohol of 90 per cent, until saturation, a compound crystallized, having the composition $NaO, 3\ C_{14}\ H_5\ O_5$. Another compound, $NaO, 2\ C_{14}\ H_5\ O_5 + 8\ HO$, was obtained by dissolving the previous one in alcohol, adding an aqueous solution of carbonate of soda without separating any gentianin, evaporating, exhausting the residue with boiling absolute alcohol, and crystallizing; the same salt was prepared by dissolving gentianin in caustic soda, evaporating, and exhausting the residue with absolute alcohol. Lastly crystals of the composition $NaO, 6\ C_{14}\ H_5\ O_5 + HO$ were formed by mixing an alcoholic solution of gentianin with aqueous carbonate of soda, without separating any gentianin, evaporating and exhausting the residue with alcohol.—The compounds with potassa agree in all their general characters with those of the soda-salts. A compound $KO, 4\ C_{14}\ H_5\ O_5 + 3\ HO$ was formed by proceeding in exactly the same way as in the preparation of the last-mentioned soda-salt. The liquid obtained by boiling caustic potassa and gentianin with alcohol of 90 per cent, deposits a compound $2\ KO, 5\ C_{14}\ H_5\ O_5 + 16\ HO$, while $KO, 2\ C_{14}\ H_5\ O_5 + 5\ HO$ crystallizes from the mother-liquor. An alcoholic solution of gentianin affords, with baryta-water, an orange-coloured flocculent precipitate, which when moist, readily absorbs the carbonic acid from the atmosphere; when rapidly washed and dried *in vacuo* or over sulphuric acid and caustic lime, it has the composition $BaO, C_{14}\ H_5\ O_5$.—Acetate of the protoxide of lead does not precipitate the alcoholic solution of gentianin, but on the addition of a few drops of ammonia to the mixture, or by precipitation with basic acetate of lead, an orange-coloured flocculent precipitate is obtained, of a composition varying according to the method adopted and the quantity of the substance employed; a compound $2\ PbO, C_{14}\ H_5\ O_5$ was obtained by precipitating an alcoholic solution of gentianin, to which a few drops of ammonia had been added, by acetate of protoxide of lead, a portion of gentianin still remaining in solution.—Gentianin, when treated with anhydrous sulphuric acid (evolution of heat being carefully avoided) yields an olive-green

Gentianin.

fluid, from which it can be again precipitated by carbonate of baryta; in concentrated sulphuric acid it dissolves with a yellow colour and is reprecipitated without change from this solution on addition of water; it is not altered by treatment with dilute sulphuric acid, even at the boiling temperature.—Nitric acid, of spec. grav. 1·43, dissolves it with a dark-green colour, on the addition of water, *nitrogentianin* is separated as a green powder; in order to obtain this compound in a pure state, the water has to be added cautiously, the liquid being constantly agitated; when dried *in vacuo*, this substance has the composition $C_{14}\,H_4\,(NO_4)\,O_5 + HO$; the water goes off at 100°. On addition of ammonia, nitrogentianin is coloured cherry-red, 1 eq. of the latter absorbs 2 eq. of ammonia-gas. Gentianin is dissolved by a more dilute nitric acid with a yellow colour, and reprecipitated by water. Fuming nitric acid attacks this substance very violently; if evolution of heat be carefully avoided and the gentianin be added gradually, a red liquid is obtained, from which a pale-yellow powder is precipitated by water; this precipitate is composed of microscopic prisms and amorphous particles, which latter may be removed by continued washing with cold water; the analysis of two distinct preparations (dried at 100°) gave 42·7 and 41·5 per cent of carbon and 2·4 and 1·8 hydrogen.—When chlorine-gas is passed into an alcoholic solution of gentianin, pale-yellow flakes, containing chlorine are produced after some time.—Gentianin, when distilled with bichromate of potassa and sulphuric acid, yields a large quantity of carbonic acid and a feebly acid distillate, in which formic and acetic acids may be detected, the latter, however, with difficulty. Baumert is of opinion that gentianin would be grouped most appropriately with colouring matters, although it is not possessed of various properties generally belonging to the latter, such as ready oxidability, deportment with chlorine, &c.

Santonin(1), which had been formerly studied by the younger Trommsdorff(2), has been again investigated by Heldt(3). It crystallizes from an alcoholic solution in nacreous prisms belonging to the rhombic system; from the ethereal solution it is deposited in rhombic tables. The composition of the crystallized santonin

(1) Cerutti obtained from 2 lbs. of wormwood-seed ½ oz. of santonin (Arch. Pharm. [2] LII, 148).—An adulteration of commercial santonin with strychnine has been observed by Walz (Jahrb. Pr. Pharm. XV, 96).

(2) Ann. Ch. Pharm. XI, 190; Berzelius' Jahresber. XV, 329.

(3) Ann. Ch. Pharm. LXIII, 10; J. Pr. Chem. XLIII, 186; Chem. Gaz. 1848, 53; J. Pharm. [3] XIII, 65.

Santonin. was found to agree with the formula $C_{30}\,H_{18}\,O_6$, representing the same atomic constitution ($C_6\,H_5\,O$) which Liebig, Ettling and Laubenheimer had derived from their researches for the fused substance; santonin dissolved in a boiling solution of potassa and slowly precipitated by acetic acid, has the same composition. The latter exhibits the peculiar property of yielding, on fusion, an amorphous, gummy mass, which, when warmed to from 40° to 50°, or exposed to the vapours of alcohol or ether, passes over into the crystalline state. Subjected to the influence of light the crystals of santonin turn yellow, and decrepitate; Heldt has examined the position of the surfaces in which this splitting takes places; they are not planes; he found this modification of santonin to have the same composition as the crystallized substance.

The combinations of santonin with bases are decomposed by boiling their solutions, santonin being separated; they are not affected by exposure to solar irradiation, nor by the carbonic acid of the atmosphere. The soluble combinations are prepared by digesting the bases, or their carbonates, with an alcoholic solution of santonin; the difficultly soluble salt by precipitating santonin-potassa, or santonin-soda, with a salt of the respective base. On digesting the bases with alcohol and santonin, the liquid assumes a carmine colour, which disappears again after some time; this colouration does not occur in the absence of alcohol. The same carmine colouration is observed, on heating the dry bases with santonin to the fusing-point of the latter; the red combination of santonin with potassa or soda, prepared in the dry way, on addition of water, becomes white after some time; Heldt believes the red colouration to be invariably due to the formation of an anhydrous santonin-compound.—Santonin-soda is prepared by digesting carbonate of soda with an alcoholic solution of santonin, until the liquid becomes colourless, evaporating the latter at 30°, exhausting the residue with absolute alcohol, and evaporating the filtrate; thus obtained it forms thin, felt-like masses of needles, the solution of which, in the smallest quantity of water, yields, by spontaneous evaporation, tolerably large transparent, rhombic crystals ($\infty P . \infty \breve{P} \infty . \breve{P} \infty$; $\infty P : \infty P$ = about 141°; $\breve{P} \infty : \breve{P} \infty$, in the brachydiagonal principal section = about 102°); they contain $NaO, C_{30}\,H_{18}\,O_6 + 8\,HO$ (7 HO escape at 100°; at a higher temperature also the last equiv. of water escapes, and a carmine-red compound is formed, which absorbs moisture with avidity, becoming white again thereby).—Santonin-potassa, prepared in the same manner, could be obtained only as a gummy uncrystal-

lizable mass. Santonin cannot be made to combine with ammonia, either in the dry or moist way.—By digesting hydrate of lime with an alcoholic solution of santonin, until the red colour of the liquid disappears, filtering, evaporating the filtrate at 30°, exhausting the residue with water of 30°, and evaporating the solution at that temperature, santonin-lime is obtained as a white mass of silky lustre, having the formula $CaO, C_{30} H_{18} O_6 + HO$, when dried at 100°. —Santonin-baryta, prepared in the same manner, has, when dried at 100°, the composition $BaO, C_{30} H_{18} O_6 + 2 HO$.—On addition of santonin to a solution of neutral acetate of protoxide of lead, a white precipitate was obtained, which, dried at 120°, was found to contain an amount of protoxide of lead, corresponding to the formula $PbO, C_{30} H_{18} O_6$; by mixing a boiling alcoholic solution of santonin with a hot aqueous solution of neutral acetate of lead, filtering, and maintaining the filtrate for some time at from 30° to 40°, a lead-compound, containing 33·6 to 33·8 per cent of protoxide of lead, was obtained, which deposited in wart-like groups of needles. Santonin.

Crystals of santonin suspended in water, when subjected to the action of chlorine-gas, become covered with an opaque white crust. The result of the action of chlorine on a hot alcoholic solution of santonin is a yellowish-red oily substance, changing to a yellowish-red resin on evaporation of the alcohol and cooling. Santonin, in a state of fusion, yields, with chlorine-gas, hydrochloric acid, and a brown resin. If santonin be dissolved in warm hydrochloric acid, with addition of a little alcohol, and small crystals of chlorate of potassa be added to the warm solution, which is continually stirred, a white amorphous mass is separated, which, washed with cold water, and dissolved in absolute alcohol (the application of heat gives rise to the formation of an orange-red resin) yields, on spontaneous evaporation, white, lustrous, delicate prisms, containing, when dried at 100°, $C_{30} H_{16} Cl_2 O_6$. This compound is fusible, and yields, when digested with potassa and alcohol, an orange-red solution, which, neutralized with sulphuric acid and evaporated, leaves a residue from which alcohol extracts an orange-red resin; on exposure to solar irradiation, this solution becomes red and then dark-brown, even in an atmosphere of hydrogen.—Iodine has no action on an alcoholic solution of santonin when heated; on exposing to heat dry iodine and santonin, until the latter fuses, hydriodic acid is evolved, and a dark-coloured mass remains, which yields, with alcohol, a cherry-red solution, becoming light-green on addition of alkalies.—Dry santonin is decomposed by bromine, with separation of carbon, and evolution of hydrobromic acid; santonin, moistened with water, or

Santonin. dissolved in hot alcohol, is converted by bromine into an orange-red resin. If bromine be added, drop by drop, to a very dilute alcoholic solution of santonin, which is kept cool, and the liquid allowed to evaporate spontaneously, small, white, wavellite-like, irregular prisms of a bromine-compound are deposited, which are insoluble in water, but are soluble in hot alcohol and ether; they fuse, and become of a fire-yellow colour when exposed to solar irradiation, with liberation of hydrobromic acid.—Santonin yields, by continued digestion with concentrated hydrochloric acid, yellow, oily drops, solidifying to a red-brown resin; the production of sugar can be traced in this reaction. Sulphuric or phosphoric acid likewise yields, with santonin, a resinous substance.—The ultimate product of the action of concentrated nitric acid on santonin, is an acid which exhibits the reactions of succinic acid; hydrocyanic acid being simultaneously formed.—On heating santonin with binoxide of lead, until the former fuses, a violent reaction ensues, attended by the disengagement of heat and light, while a yellow vapour of a pungent odour distils over, which condenses to a mixture of an orange-red resin and santonin.

Heldt classes santonin among the resins, and communicates his views respecting the formation of these latter substances (vide II. p. 55).

Lepage(1) has made some communications respecting a peculiar substance in the bark of the beech-tree (*Fagus sylvatica*), and Gerding(2) on a substance in the fresh herb of *Œnanthe fistulosa*. The statements of both are so incomplete, as to admit of no definite report.

Asparagin.—Piria has made a more detailed communication(3) of his researches on asparagin, which had been partly published at a former period(4). Having allowed 10 kilogrammes of vetches to germinate in a dark place, he cut off the plants when they had reached a height of 60 centimetres, concentrated the expressed juice, separated the solution, by filtration, from the albumin that deposited, and purified the asparagin that crystallized from the concentrated filtrate by recrystallization and treatment with animal charcoal. He thus obtained 150 grms. of pure asparagin. He obtained an equal

(1) J. Chim. Méd. [3] III, 513; J. Pharm. [3] XII, 181.

(2) J. Pr. Chem. XLIV, 175.

(3) Compt. Rend., 16 Septbr., 1844; Berzelius' Jahresber. XXV, 714; XXVI, 708.

(4) Ann. Ch. Phys. [3] XXII, 160; J. Pr. Chem. XLIV, 71; Ann. Ch. Pharm. LXVIII, 343 (in abstr.)

Asparagin.

amount of this substance from green vetch-plants which grew exposed to the light. He could not detect a trace of it in the seeds themselves. On examining the vetches when they commence to bloom, and during the formation of fruit, he once obtained an amount of asparagin too small to estimate, another time none at all.—Piria confirms the formula $C_8 H_{10} N_2 O_8$, of crystallized asparagin, but found that this substance contains, in addition to the two equivs. of water expelled by desiccation at 120°, a third equiv., which is replaceable by bases. Asparagin is possessed, according to Piria, of acid properties sufficiently powerful to redden litmus, and to expel acetic acid from its combination with protoxide of copper. A compound of protoxide of copper is obtained by heating both substances with a small amount of water, or by adding a hot saturated solution of asparagin to a solution of acetate of copper, likewise hot and concentrated. In both cases a beautifully ultramarine-blue precipitate, CuO, $C_8 H_7 N_2 O_5$, is deposited, almost insoluble in cold, slightly soluble in boiling water, but dissolving readily in acids and in ammonia; it may be exposed to 120° without losing water, but is decomposed at a higher temperature, with evolution of ammonia; by treatment with hydrosulphuric acid, it may be reconverted into crystalline asparagin.—A solution of pure asparagin is not altered by standing for some time; a solution of the impure and coloured crystals, however, undergoes a kind of fermentation, the liquid becomes slightly alkaline, and evolves the odour of putrid animal matter, while the asparagin gradually disappears, and is replaced in the liquid by ammonia and succinic acid. In this metamorphosis crystallized asparagin assimilates 2 equivs. of hydrogen ($2\,[NH_4 O, C_4 H_2 O_3] = C_8 H_{10} N_2 O_8 + 2\,H$); a solution of pure asparagin, after addition of vetch-juice, undergoes the same decomposition(1). —Piria repeated the observation made previously, that asparagin, when boiled with pure hydrochloric acid, or with nitric acid, free from hyponitric acid, is converted into ammonia and aspartic acid, the formula of which, $C_8 H_7 N O_8$, he confirmed(2). He contradicts, however, the statement that aspartic acid, on continuous ebullition

(1) An assimilation of hydrogen has not, as yet, been observed in any fermentative process. Piria does not state what becomes of the oxygen of the water. We may here recal the fact that asparagin ($C_8 H_{10} N_2 O_8$) contains the elements of succinic acid ($C_4 H_2 O_3$), tartaric acid ($C_4 H_2 O_5$), and ammonia ($2\,NH_3$); the fermentation of tartaric acid is well known.

(2) Laurent (Ann. Ch. Phys. [3] XXIII, 113; J. Pr. Chem. XLV, 170) is inclined to consider aspartic acid ($C_8 H_7 N O_8$), not as a bibasic acid ($2\,HO, C_8 H_5 N O_6$), but as a monobasic acid ($HO, C_8 H_6 N O_7$).

Asparagin.

with concentrated hydrochloric acid, yields a new very soluble acid. He finds that hydrochloric acid pertinaciously adheres to aspartic acid, which thus becomes deliquescent. By precipitating a solution of aspartic acid with acetate of lead, Piria once obtained white, brilliant, needle-shaped prisms of a double-salt of aspartate, and nitrate of lead ($PbO, HO, C_8 H_5 N O_6 + PbO, NO_5$), slightly soluble in cold, and decomposed by boiling water; he did not succeed in reproducing this compound.—Nitric acid, containing hyponitric acid, converts both asparagin and aspartic acid into malic acid, nitrogen being disengaged. Asparagin and aspartic acid may be considered as the amidogen-compounds of malic acid; asparagin is neutral malate of ammonia minus 2 equivs. of water ($C_8 H_8 N_2 O_6 = 2 N H_4 O, C_8 H_4 O_8 - 4 HO$), aspartic acid bimalate of ammonia minus 2 equivs. of water ($C_8 H_7 N O_8 = N H_4 O, HO, C_8 H_4 O_8 - 2 HO$). Piria has also found that other amides, when subjected to the action of hyponitric acid, evolve nitrogen, the acid being reproduced, whose ammonia-salt had given rise to the formation of the amide.—If asparagin be fused with potassa, it disengages ammonia, and subsequently hydrogen, while acetic and oxalic acids are formed.

Dessaignes and Chautard(1) have found asparagin also in the shoots of peas, beans, lentils, and kidney-beans, which had been grown in a cellar; 9 litres of juice from the shoots of the pea gave 83 grms., 2,53 litres of juice from the bean-shoots 33 grms., and 1·35 litres of juice from the kidney-bean-shoots 7·4 grms. of pure asparagin. They likewise confirmed the formula $C_8 H_{10} N_2 O_8$, adopted for asparagin in the crystallized state. 7·25 litres of the sap of vetches grown in the soil, gave 67 grms., and 3 litres of sap from vetches, which struck root in moist hemp, 27 grms. of asparagin; the sap of the roots of the latter was likewise rich in asparagin, but none was discovered in the cotyledons. In the shoots which dahlia-tubers had put forth in a cellar, and even in the tubers themselves, asparagin was likewise found; it was also met with in the shoots of the marsh-mallow, which were grown in the dark; none, however, was found in potato-shoots under similar circumstances. A boiling solution of asparagin dissolves protoxide of silver; by spontaneous evaporation of the solution over sulphuric acid in the dark, fungiform crystalline aggregates are produced, which become rapidly black in reflected, and brownish-yellow in transmitted light; when dried *in vacuo*, their composition was found to be expressed by $AgO, C_8 H_7 N_2 O_5$.

(1) J. Pharm. [3] XIII, 245; J. Pr. Chem. XLV, 50; Ann. Ch. Pharm. LXVIII, 349 (in abstr.)

Asparagin.

On ebullition, asparagin slowly expels the acetic acid from an aqueous solution of acetate of protoxide of lead; on evaporating the liquid over sulphuric acid, a gummy mass remains behind, which is difficult to dry at 100°.—Protoxide of mercury readily dissolves in a hot solution of asparagin. The concentrated liquid yields a white precipitate on addition of water; on evaporation it dries up to a gummy mass, and appears to be decomposed at 100°.—From a solution of protoxide of zinc in a boiling solution of asparagin white leafy crystals are deposited on cooling, which do not lose water, when dried at 100°, and whose composition is represented by $ZnO, C_8 H_7 N_2 O_5$.—Asparagin and nitrate of protoxide of silver dissolved together in water in the relative proportions of $C_8 H_{10} N_2 O_8$ and 2 (AgO, NO_5) yield, on the cooling of the solution, small crystals whose silver-percentage agrees with the formula $C_8 H_8 N_2 O_6 + 2 (AgO, NO_5)$. By proceeding in a similar manner with nitrate of protoxide of lead, only a gummy mass was obtained.—Definite compounds of asparagin with sulphuric or hydrochloric acid could not be produced. A crystalline compound with oxalic acid is stated to be obtained by dissolving the crystallized acid and asparagin in the relative proportions by weight of 2 $(3 HO, C_2 O_3)$ and $C_8 H_{10} N_2 O_8$, and slowly evaporating the solution, when an aggregate of small crystals of the formula $C_8 H_8 N_2 O_6 + 2 (HO, C_2 O_3)$ is deposited. Dessaignes and Chautard prefer for the latter compound the formula $C_4 H_4 N O_3 + HO, C_2 O_3$; in general they are of opinion that the equivalent of dried asparagin is expressed by $C_4 H_4 N O_3$. In addition, they mention that chlorine readily changes asparagin even in diffused light, and that binoxide of lead decomposes it on ebullition with evolution of ammonia, but without giving rise to the formation of aspartic acid.

Amygdalin.—Wöhler(1) has investigated the action of acids, especially of hydrochloric acid, upon amygdalin. This compound $(C_{40} H_{27} N O_{22})$ from the metamorphosis which it undergoes when treated with emulsin, may be considered as a conjugate compound of bitter-almond oil, hydrocyanic acid and sugar $(C_{40} H_{27} N O_{22} = C_{14} H_6 O_2 + H C_2 N + 2 C_{12} H_{10} O_{10})$, but likewise as consisting of a cyanogen-compound, $C_{14} H_5, C_2 N$, and 2 equivs. of gum $(2 C_{12} H_{11} O_{11})$, in which latter case the transference of 2 equivs. of water from the gum to the former compound might induce the formation of sugar, hydrocyanic acid and bitter-almond oil. The action of acids upon

(1) Ann. Ch. Pharm. LXVI, 238; J. Pr. Chem. XLIV, 382; Pharm. Centr. 1848, 840; Instit. 1848, 298.

Amygdalin.

amygdalin agrees with both modes of viewing it; for under the influence of these agents it is converted into formobenzoic acid and an ulmin-body, while the whole of the nitrogen is separated in the form of an ammonia-salt. We may assume that either the sugar or the gum induces the formation of the ulmin-body, while the formic acid arising from the hydrocyanic acid unites with bitter-almond oil to produce formobenzoic acid. Wöhler has examined chiefly the action of hydrochloric acid, but has no doubt that all strong acids will be found to comport themselves in a similar manner. A solution of amygdalin in fuming hydrochloric acid assumes a yellow and subsequently a brown colour; on application of heat a large quantity of a dark-brown ulmin-body separates in the form of powder. The filtrate of the latter yields a dark-brown syrupy residue, containing formobenzoic acid which may be extracted with ether, humic acid, and chloride of ammonium. If on evaporation of the acid liquid the temperature rises above 100^0, a portion of the formobenzoic acid undergoes a peculiar change; it becomes amorphous, it still dissolves in a small quantity of water, but is, on addition of a larger amount of water, again precipitated from this solution as a heavy, yellow, inodorous oil.—By passing hydrochloric acid gas into a pasty mixture of amygdalin and alcohol, the former is gradually dissolved without separating again on cooling; in this process no ulmin-body is formed, the liquid assuming only a feebly-brown colour. After some days chloride of ammonium is deposited, and an addition of a large amount of ether causes the separation of an acid aqueous liquid, containing the whole of the chloride of ammonium, but no sugar. The ethereal liquid leaves, on evaporation, a brown syrup which Wöhler considers to be amygdalic ether, produced by the sugar or gum contained in amygdalin combining with the formobenzoic acid produced, without being converted into the ulmin-body; for, amygdalic acid may be considered as a compound of bitter-almond oil, formic acid, and sugar, $HO, C_{40} H_{26} O_{24} = C_{14} H_6 O_2 + C_2 H O_3 + 2 C_{12} H_{10} O_{10}$. Amygdalic ether is heavier than water and dissolves in water in considerable quantity, especially on application of heat, which, however, induces decomposition; it has a bitter and somewhat astringent taste, and can be only slightly volatilized without decomposition.

Vegetal Chemistry. Absorption of Inorganic Substances.—Chevallier(1) has communicated several observations respecting the

(1) J. Chim. Méd. [3] IV, 602.

Absorption of inorganic substances

absorption of inorganic substances by plants. Pepper-wort (*Lepidium sativum*) was planted in earth, watered either with an aqueous solution of tartar-emetic, blue-vitriol, or sugar of lead; antimony, copper, lead were found respectively in the stalks of the plants, but only copper or lead in the seeds. He found lead in plants grown in a white-lead manufactory, and he likewise confirmed the observation that chloride of sodium is absorbed by plants.

Lassaigne(1) has described some experiments, according to which it appears, that wheat planted in quartz-sand thrives more luxuriantly when watered with water containing in solution (comp. I. p. 225), carbonic acid and phosphate of lime, than when pure water only is employed.

The action of arsenious acid upon plants has been investigated by Chatin(2). He states, that this acid is to a certain extent absorbed by plants, and that, if they are not destroyed by the influence of the poison, it is, at a later period, again ejected by the roots. He has examined the conditions which favour either the action of the poison or its secretion; we mention here only that the action of the poison on the various kinds of plants exhibited a remarkable difference, phanerogamia dying earlier than the cryptogamia, and the dicotyledons sooner than the monocotyledons.—Filhol(3) has confirmed the statements of Chatin; and he has, moreover, minutely investigated the unequal distribution of the arsenic absorbed throughout the various parts of plants; he finds that arsenic acid, employed in the same proportion and in an equal state of dilution, has a more poisonous action upon plants than is exhibited by arsenious acid.

E. Gris(4) observes that chlorotic plants, *Quercus coccinea, Quercus phellos, Castanea americana,* &c., are sustained by watering with, or immersion in, a solution of sulphate of protoxide of iron (from 1 to 8 grms. in the litre).

Reaction of the Sap of Plants.—Gaudichaud(5) has stated that the sap of all plants is found to have an acid reaction. On the other hand, Payen(6) has observed that an accurate insight into this subject can only be attained by investigating the fluids contained in the various parts or organs, or even those occurring in the individual cells; in the various organs of a plant the sap is found to present an acid, a neutral, or an alkaline reaction. He reminds us of the fact,

(1) J. Chim. Méd. [3] IV, 534.
(2) Ann. Ch. Phys. [3] XXIII, 105; J. Pr. Chem. XLV, 122.
(3) J. Pharm. [3] XIV, 401.
(4) Compt. Rend. XXV, 276.
(5) Ibid. XXVI, 657.
(6) Ibid. XXVII, 1.

Reaction of the sap of plants.

which he has communicated elsewhere(1), concerning the leaves of the plants belonging to several groups of the family *Urticeæ*. Some cells of these leaves, having from 10 to 20 times the size of those which surround them, contain concretions of carbonate of lime and a neutral or feebly alkaline sap, while that which is contained in the adjoining cells has an acid reaction. The vesicles with which the leaves and stalks of *Mesembrianthemum crystallinum* are covered, contain a liquid of an alkaline reaction, while the sap of the entire interior formation is acid.—In reply, Gaudichaud(2) now considers the predominating acid reaction as belonging to the essential sap of plants; he also supposes that certain milky juices are neutral, although the plants from which they are derived, have an acid reaction.

Milky Juice of Lactuca Virosa.—By exhausting lactucarium (the dried juice of *Lactuca virosa*) with boiling alcohol Lenoir(3) had obtained a crystalline substance, which he had designated *lactucone*, and whose composition he had found to be expressed by $C_{40}\ H_{32}\ O_3$. —Walz(4) expresses the opinion that Lenoir's lactucone is nothing but the body formerly described by him under the name of "lettuce-fat."—Lactucarium has been again investigated under the direction of Wackenroder, by Thieme, Ruickoldt, and especially by H. Ludwig, and comprehensive statements respecting this substance have been published by the latter(5).—Ruickoldt found in lactucarium a peculiar compound, to which he assigned the name *lactucerin*, and which Ludwig, by a more accurate investigation, proved to be identical with lactucone.—Ludwig considers the bitter principle of lactucarium to be an acid, and proposes to term it *lactucic acid*. For the preparation of this body equal weights of pulverized lactucarium and dilute sulphuric acid are rubbed together; five times its weight of alcohol, of 84 per cent, is then added, the solution filtered, and the filtrate agitated with caustic lime; the filtrate from the lime is decolourized with animal charcoal and evaporated, the residue heated to ebullition with a large amount of water, and the aqueous solution thus obtained again decolourized by animal charcoal; on evaporation, a mixture of lactucic acid and the crystalline body, described by Aubergier(6) under the name of *lactucin*, remains behind. From

(1) Recueil des Mémoires des Savants Étrangers, IX, 77.
(2) Compt. Rend. XXVII, 3.
(3) Ann. Ch. Pharm. LIX, 83; Berzelius' Jahresber. XXVII, 483.
(4) Jahrb. Pr. Pharm. XIV, 25.
(5) Arch. Pharm. [2] L, 1. 129.
(6) Quesneville's Revue Scientifique, XI, 98; Berzelius' Jahresber. XXIV, 522.

Milky juice of Lactuca virosa.

the solution in boiling water the lactucin separates on cooling, and the mother-liquor yields on evaporation impure lactucic acid. This substance forms a bright-yellow amorphous mass, becoming crystalline after long standing; its colourless aqueous solution assumes a wine-red colour, when mixed with an alkali; on ebullition with sulphate of copper and excess of soda, it reduces the hydrated protoxide to the state of suboxide.—Ludwig considers the constituents of German lactucarium to be 44·4 to 53·5 per cent of lactucone; a soft resin; about 4 per cent of a readily fusible waxy body; lactucin, on which its action mainly depends, and which, on ebullition with sulphate of copper and soda-solution, likewise effects a reduction of the oxide to the state of suboxide; lactucic acid; about 1 per cent of oxalic acid; a non-volatile, non-bitter acid, reducing protoxide of silver, and a volatile acid of an odour resembling that of valerian, both occurring in very trifling proportions; nearly 7 per cent of albumin; at least 2 per cent of mannite; a non-bitter, neutral, unfermentable substance, crystallizing in rhombic pyramids, and occurring only in trifling quantity; and lastly, 3 to 6 per cent of ash, which contains potassa, soda, sesquioxide of manganese, sesquioxide of iron, and a trifling quantity of lime.—In lactucarium, dried at 100°, which was prepared from fresh *Lactuca virosa*, cultivated near Jena, Ludwig found:

Lactucone	42·64	48·63 per cent of constituents, insoluble in water.
Readily fusible, waxy body	3·99	
Vegetal fibre, with a substance swelling up in ammonia, and insoluble in water, alcohol, and ether	2·00	
Albumin coloured slightly grey	6·98	51·37 per cent of constituents, soluble in water.
A very bitter extract, soluble in water and in spirit of wine, of a spec. grav. 0·830 (at 23°)	27·68	
An aqueous extract, insoluble in spirit of wine, of a spec. grav. 0·830	14·96	
Lactucone held in the aqueous solution by means of the other substances	1·75	

Buchner Sen.(1) has given a synopsis of the chemical and pharmacological facts which are known respecting the *Lactuca*.

Influence of Water upon Germination.—Cap(2) has communicated his views respecting the influence of water upon the process of germination; they contain nothing new, and do not require a special report.

(1) Repert. Pharm. [2] XLVII, 19.
(2) Compt. Rend. XXVI, 635; J. Pharm. [3] XIV, 107; J. Pr. Chem. XLV, 250.

Radix Meu.

Radix Meu.—Reinsch, who had previously(1) investigated *Radix Meu*, has now(2) found that it contains mannite; he states, moreover, that the resin of this root forms a crystalline compound with potassa; that by treatment with absolute alcohol and hydrochloric acid gas it yields an ethereal substance, and that it is converted by distillation into a very volatile, yellowish oil.

Raddish-root.—Thornton J. Herapath(3) has found the roots of raddish (*Raphanus sativus*) to be composed, in 100 parts, of:

Water	95·974	Fatty oil	0·040
Woody fibre	1·702	Sinapin?	0·004
Nitrogenous substance with some starch	0·204	Earthy phosphates and carbonates with some sulphate of lime	0·074
Albumin	0·091	Acetate of potassa and soda	0·022
Extractive matter	0·226	Nitrate of potassa and soda	0·517
Gum	0·430	Chloride of sodium and chloride of potassium	0·416
Sugar	0·114		
Red colouring matter	0·177		

Distribution of Starch and Sugar in Various Roots.—Payen(4) has investigated the distribution of starch through the various parts of the root of *Dioscorea alata;* he has determined, moreover, the composition: 1. of the entire root in the fresh state; 2. of the central portion of the root; and 3. of the lower extremity; the two latter in the dry state:

	1.	2.	3.
Water	79·64	—	—
Non-nitrogenous organic constituents	17·33	85·01	74·56
Nitrogenous organic constituents	1·93	9·49	16·44
Inorganic constituents	1·10	5·50	9·00

He has likewise made some researches respecting the seat of the secretion of starch and vegetal mucilage in the tubers of *Orchis palmata* and *latifolia*(5); and also respecting the distribution of sugar and other proximate constituents in the beet-root(6). These investigations being foreign to the special object of this report, we refrain from entering into details. Barreswil and Michelot have likewise made a series of experiments upon the amount of sugar in the beet-root, of which, however, only short abstracts(7) have as yet been published, containing no minute statements respecting the individual results.

(1) Jahrb. Pr. Pharm. II, 388.
(2) Ibid. XIV, 388.
(3) Chem. Gaz. 1847, 279.
(4) Compt. Rend. XXV, 147, 182.
(5) Compt. Rend. XXV, 380.
(6) Ibid. XXIV, 909, 985.
(7) Ibid. XXV, 262.

Red-beet.—L. Meier(1) communicates an investigation of the red-beet (*Beta vulgaris*), and finds its constituents to be fat, resin, cane-sugar, uncrystallizable sugar, dextrin, lactic acid, erythrobetic acid, gum, inulin (?), pectic acid, butyric acid (?), woody fibre, a nitrogenous substance soluble in alcohol, chloride of calcium, sulphate of magnesia, sulphate of lime, carbonate of soda, carbonate of lime, phosphate of lime, phosphate of magnesia, sesquioxide of iron, and silicic acid.—Meier designates as *erythrobetic acid* a very unstable acid, which is obtained by precipitating the aqueous extract of the dried root with acetate of protoxide of lead, exhausting the precipitate with boiling water, and decomposing it by means of oxalic acid and alcohol, at a temperature not exceeding 60°, evaporating the liquid at from 40° to 50°, and treating the red coloured residue with alcohol, which dissolves xanthobetic acid, and leaves erythrobetic acid behind; it is soluble in water, the solution yields, on slow evaporation, indistinct, spear-like crystals, which deliquesce in the air, with a brown colouration: this acid gives, with acetate of protoxide of lead, a red precipitate, in whose decomposition with hydrosulphuric acid, the erythrobetic acid itself is decomposed.—Meier terms *xanthobetic acid* an acid which is obtained in somewhat larger quantity by exhausting, with cold water, the roots dried at a pretty high temperature, precipitating the extract with acetate of lead, and repeatedly treating the precipitate with boiling water. By adding alcohol of 80 per cent, and dilute sulphuric acid, and evaporating, the precipitate is decomposed, and a brown residue left, which is treated with cold alcohol. On evaporating the alcoholic solution to dryness xanthobetic acid remains as an amorphous reddish-yellow mass, attracting moisture from the atmosphere, and dissolving only with difficulty in ether, but more readily in alcohol and water. The solution of this acid assumes a rose-red colour by the action of the alkalies, with which it forms crystallizable salts; with acetate of protoxide of lead it produces a yellowish-brown precipitate.—Buchner, Sen.(2) has described several reactions of the juice of the beet; he finds it to contain, moreover, malic acid, nitrate of potassa, and an ammonia-salt. Red-beet.

Guaiacum-wood.—Riegel(3) has given a synopsis of his own observations, with those of others, upon the wood and resin of guaiacum; he considers the constituents of the wood to be resin,

(1) Repert. Pharm. [2] XLV, 1, 157. (2) Ibid. XLV, 175.
(3) Jahrb. Pr. Pharm. XIV, 243.

Guaiacum-wood.

guaiacin, mucilaginous extractive matter (gum ?), a peculiar acid (guaiacic acid), potassa, soda, lime, chlorine, and sulphuric acid.

Quina-bark.—Several chemical investigations of quina-barks have been published: of the red or dark Para-Quina by Winckler(1); of a bark, erroneously designated King's-Quina, by Reichel(2); and of Yellow-Quina by Gulliermond(3).

Senna-leaves.—Bley and Diesel(4) found senna-leaves to contain no ethereal oil; the leaves of various kinds gave from 11 to 12 per cent of ash, consisting of phosphate and carbonate of lime, chloride of potassium, traces of soda, and silicic acid; the leaves, in addition to woody fibre, contain a yellow, resinous substance, designated by Bley and Diesel *chrysoretin*, a brown resin, a brown extractive matter (Lassaigne and Feneulle's cathartin), pectin, gummy extractive matter, chlorophyll, and some fat.

Pollen.—By exhausting, with water, alcohol, and ether, the pollen of the red and white lily (*Lilium bulbiferum* and *candidum*), Thornton J. Herapath(5) obtained a lemon-yellow residue, which he terms pollenin. This substance is dissolved, without change, in cold nitric acid, and separated again on addition of water; on ebullition it is decomposed, without, however, forming either oxalic or picric acid. The pollen of the lily contains no starch; a peculiar colouring matter is met with in the red lily, which is not found in the white species. In the pollen of *Cactus speciosissimus* the interior of the pollen-grains appears to be formed of starch. The amount of pollenin in 100 parts of pollen was found to be, in *Lilium bulbiferum* 43·0, in *Lilium candidum* 36·9, in *Cactus speciosissimus* 46·6.

Lycopodium.—Ducom(6) found in the lycopodium from 62·27 to 64·80 per cent of carbon, 8·73 to 8·80 of hydrogen, 6·18 of nitrogen, and from 20·22 to 22·78 of oxygen. Ether removes from it a fatty acid, in which were found from 67·54 to 68·45 per cent of carbon, and from 9·43 to 9·99 of hydrogen.

Berries of Vitis sylvestris.—In the berries of the wild vine (*Vitis sylvestris*) Riegel(7) finds chlorophyll, resin, red colouring matter, pectin, gum, grape-sugar, malic acid, tartaric acid, citric acid, and small quantities of lime and potassa.

Fruit of Euonymus Europæus.—In the seed-capsules of the fruit of

(1) Repert. Pharm. [2] XLVI, 341.
(2) Arch. Pharm. [2] LIII, 288.
(3) J. Pharm. [3] XI, 437.
(4) Arch. Pharm. [2] LV, 257.
(5) Chem. Soc. Qu. J. I. 1.
(6) From Recueil, etc. (comp. II. p. 3), Avril 1847, 65 in J. Pharm. [3] XII, 132.
(7) Arch. Pharm. [2] LV, 150.

Fruit of Euonymus Europæus.

Euonymus Europæus Grundner(1) found gummy extractive matter, grape-sugar, resin, soft resin, cerin, tannic acid, extractive colouring matter, together with potassa, lime, and magnesia, in the form of citrates, hydrochlorates and sulphates. The orange coloured *arillus* was found to contain a very large quantity of a fatty oil of a similar colour; the rose-red seed-envelope contains a considerable amount of tannic acid and gum, as well as potassa, lime, and magnesia, in combination with hydrochloric and sulphuric acids; in the seed, lastly, he found 28·1 per cent of fatty oil, and 3·9 of resin, as well as bitter extractive matter, emulsin, sugar, and gum, together with potassa, lime, and magnesia, in the form of tartrates, hydrochlorates, and sulphates.

Gourd.—By way of comparison with the ordinary gourd (A), Braconnot(2) has examined a kind imported from the Island of Corfu(B), which is recommended under the name of *ami des pauvres*. The ordinary gourd-fruit has been investigated also by Zenneck(3); we give his results under C.

	A.	B.
Water	93·48	95·40
Albumin	0·39	0·26
Orange-red fat	0·06	0·04
Animal matter with sugar	1·10	0·77
Mucilaginous matter, insoluble in alcohol	2·90	2·04
Woody fibre	1·32	0·93
Phosphate of lime	0·12	0·09
„ „ potassa	0·06	0·04
Malate of lime	0·57	0·43
Ammonia-salts, chloride of potassium, and sulphate of potassa	traces.	—
	100·00	100·00

	C.
Water	89·50
Gelatic acid	0·16
Starch, containing sugar	1·32
Sugar	4·83
Yellow colouring matter	0·09
Fibre	1·59
Soluble ash-constituents	0·91
Insoluble „ „	0·67
Loss	0·93
	100·00

Horse-chestnut; Removal of its Bitter Principle.—Even before the commencement of the present century chemists have endeavoured to render the horse-chestnut edible, by the removal of the bitter principle which so closely adheres to its starch. The method communicated at that time by Bon and Parmentier, namely, of extracting the bitter with an alkaline liquid, has been frequently employed(4). In France lime was used for this purpose; Bachmann, in his pamphlet, "*Ueber die Benutzung der Rosskastanien und Eicheln*," recommends potassa; Hedenus, in a similar treatise, containing

(1) Repert. Pharm. [2] XLVII, 315.
(2) Ann. Ch. Phys. [3] XX, 357; J. Pr. Chem. XLI, 468.
(3) Jahrb. Pr. Pharm. XIV, 316.
(4) Schlofsberger in Dingl. Pol. J. CXI, 77.

Horse-chestnut; removal of its bitter principle.

the results of some experiments undertaken by order of the Government of Saxony, advises the employment of ammonia.—Recently, this old process has been rediscovered in France, by Flandin, where it has occasioned great sensation; in the place of the alkaline substances mentioned Flandin employs soda. The shelled and powdered chestnut-fruit is to be kneaded with from $\frac{1}{60}$ to $\frac{1}{100}$ of its weight of soda, and then exhausted with water; the green coloured water employed in washing, deposits brilliant-white starch, of pure flavour, and which may be employed as an admixture ($\frac{1}{5}$) to wheaten-flour(1). Belloc stated, at a later period, that pure water alone acts in the same manner as water containing soda in solution, whereupon Flandin rejoined, that it is not only the bitter, but also an acrid taste, arising from an acid resin, that has to be removed, for which purpose soda only answers.(2)

Mercurialis annua.—Incidentally to another investigation, Buchner, Sen.(3) has made some communications respecting the constituents of *Mercurialis annua.*

Cetraria islandica.—Knop and Schnedermann, in continuing their earlier investigations of the lichens, especially of the *Cetraria islandica*(4), have now examined the constituents of the latter plant generally(5). In the entire lichen, dried at 120°, they found 43·6 per cent of carbon and 5·8 of hydrogen, 0·5 of nitrogen, 49·1 of oxygen, and 1·0 of ash; 100 parts of the latter containing from 40·0 to 43·7 of silicic acid, 20·3 of potassa, 2·3 of soda, 5·8 of lime, 8·3 of magnesia, 6·9 of sesquioxide of iron, 7·2 of sesquioxide of manganese, and 6·5 of phosphate of sesquioxide of iron. In 100 parts of lichen are contained about 70·0 of lichen-starch, 16·7 of lichen-cellulose, 2·0 of cetraric acid, 0·9 of a fat, lichesteric acid and another body, 8·0 of sugar, gum, extract (?) and fumaric acid, a nitrogenous body, and less than 0·001 of lichulmic acid and thallochlore. —The cellulose, which only with difficulty could be obtained pure, and never colourless, by alternately exhausting the lichen with hydrochloric acid and a mixture of ammonia and spirit of wine, they found to have a composition agreeing with the formula $C_{24} H_{21} O_{21}$. Lichen-starch assumes a blue colour with iodine-water, but loses this property when dissolved, by ebullition, in water; its composition is

(1) Compt. Rend. XXVII, 349, 391; Dingl. Pol. J. CX, 319; Monit. Industr. 1848, No. 1282 and 1285.

(2) Compt. Rend. XXVIII, 83, 138; Dingl. Pol. J. CXI, 466.

(3) Repert. Pharm. [2] XLVI, 183.

(4) Ann. Ch. Pharm. LV, 144; Berzelius' Jahresber. XXVI, 535.

(5) J. Pr. Chem. XL, 385.

expressed by $C_6 H_5 O_5$. Lichulmic acid, $C_{30} H_{13} O_{13}$, is formed by the oxidation of the cetrarates. Knop and Schnedermann have ascertained by what solvents the various constituents may be removed from the plant, and in what manner they are altered by atmospheric influences. Cetraria islandica.

Confervæ.—Mitscherlich(1) has investigated the development and composition of the *Conferva glomerata;* we adduce here only the chemical results. The plant consists of cells, which are covered with a continuous membrane (epidermis), and filled with a gelatinous substance. The walls of the cells are formed of cellulose, which, on addition of iodine (of a solution of iodine in iodide of potassium, or iodide of sodium), assumes a brown colour, changing to blue by subsequent treatment with sulphuric acid,—previously to the cellulose being dissolved by the acid. The substance composing the epidermis differs from cellulose; it resembles the cellular substance of yeast more than anything else. The gelatinous contents of the cells is of a green colour, from the presence of a minute quantity of chlorophyll; it assumes a brown colour on addition of iodine. Confervæ, developed under circumstances which precluded the access of dust, when dried at 130°, were found to contain 45·70 per cent of carbon, 5·83 of hydrogen, 5·60 of nitrogen, 30·60 of oxygen, and 12·27 of ash; the latter containing 0·16 sulphate of potassa, 0·05 chloride of potassium, 1·53 phosphate of lime, 2·14 carbonate of lime, 0·62 carbonate of magnesia, 0·42 alumina, and 7·35 sand and silicic acid.

For the composition and development of plants, as well as for the composition of the ashes of plants, we refer also to our Report on Agricultural Chemistry; on "Ripening of Fruits," comp. II. p. 108.

Proportion of Sulphur and Phosphorus in Plants.—H. C. Sorby(2) has made a series of experiments upon the amount of sulphur and phosphorus contained in agricultural produce, which, as is well known, does not admit of being calculated with any degree of certainty from the acids in the ash. He boiled the vegetables with nitric acid until they were completely destroyed, and then filtered. Sorby does not, however, mention whether, in this process, chlorate of potassa was used, as proposed by Erdmann. After precipitating the filtrate with chloride of barium, and separating the sulphate of baryta, the liquid was mixed with a small quantity of acetate of lead, and then with a slight excess of caustic ammonia; the precipitate,

(1) Berl. Acad. Ber. 1847, Nov. 430; J. Pr. Chem. XLIII, 158; Instit. 1848, 186.

(2) Phil. Mag. [3] XXX, 330; Chem. Soc. Mem. III, 281; Dingl. Pol. J. CV, 227; J. Pr. Chem. XLI, 141; Pharm. Centr. 1847, 567.

Proportion of sulphur and phosphorus in plants.

thus obtained, was washed, dried, and cautiously decomposed by heat into a mixture of lead, protoxide, and phosphate of protoxide of lead; this mixture, lastly, was dissolved in nitric acid, treated with ammonia, until a precipitate of the basic nitrate of lead was formed, and subsequently mixed with acetic acid, which left phosphate of protoxide of lead undissolved. The following numbers exhibit the amount of sulphur and phosphorus contained in 100 parts of substance, dried at 100°(1).

	Proportion of:			Proportion of:	
	Sulphur.	Phosphorus.		Sulphur.	Phosphorus.
Poa palustris and *trivialis*; *Festuca pratensis*, *Cynosurus cristatus*	0·165	0·164	Straw from the above	0·240	0·132
Lolium perenne	0·310	0·183	Ear of wheat when ripe	0·090	0·336
Italian rye-grass	0·329	0·145	Straw from the above	0·213	0·043
Trifolium pratense	0·107	0·149	Red wheat	0·070	0·363
Ditto	0·087	0·131	Ditto, straw	0·293	0·079
Trifolium repens (very fine kind)	0·099	0·183	White wheat from the same field as the above red	0·054	0·366
„ „ (ordinary kind)	0·151	0·139	Ditto, straw	0·207	0·112
Medicago lupulina (very fine)	0·136	0·052	Wheat (another sample)	0·051	0·410
Medicago sativa	0·274	0·046	Ditto, chaff	0·091	0·252
Ditto	0·452	0·215	Very fine barley (*Hordeum distichum*)	0·066	0·498
Ditto	0·293	0·353	Ditto, straw	0·390	0·087
Vicia sativa	0·178	0·183	Rather poor barley	0·040	0·367
Kidney potatoes (*Solanum tuberosum*	0·094	0·213	Ditto, straw	0·191	0·065
Tops of ditto	0·389	0·357	Barley-plant when in flower	0·313	0·236
Fruit of ditto	0·071	0·597	Oat-plant (*Avena sativa*) when just coming into flower	0·226	0·194
American potatoes	0·082	0·212	Ditto, in flower	0·189	0·189
Tops of ditto	0·206	0·483	Green oats	0·125	0·317
Daucus carota, roots	0·092	0·255	Straw of ditto	0·329	0·128
„ „ tops	0·745	0·382	Black tartarian oats	0·080	0·381
Beta altissima, roots	0·058	0·190	Straw of ditto	0·271	0·110
„ „ tops	0·502	0·293	White oats	0·090	0·334
Brassica rapa, roots	0·351	0·352	Straw of ditto	0·401	0·153
Ditto	0·421	0·346	White oats (another sample)	0·074	0·382
„ „ tops	0·758	0·360	Straw of ditto	0·195	0·057
Ditto	0·615	0·380	Rye-ears (*Secale cereale*) when young	0·073	0·076
Brass. oleracea (Swedish turnip)	0·435	0·172	Straw of ditto	0·099	0·153
„ „ tops	0·458	0·250	Rye	0·051	0·160
Brassica oleifera (rape)	0·448	0·233	Bean-plant (*Vica faba*) in flower	0·045	0·258
Brassica campestris (drum-head cabbage)	0·431	0·267	Beans	0·071	0·600
Wheat-plant entire (*Triticum vulgare*) when just gone out of flower	0·151	0·248	Ditto, straw	0·148	0·233
Ditto	0·170	0·140	Peas (*Pisum sativum*)	0·158	0·206
Ear of the wheat when the grain was formed, but still milky	0·075	0·271	Ditto, straw	0·214	0·076
			Fine hops (*Humulus lupulus*)	0·127	0·574
			Bind of ditto	0·091	0·138

(1) Compare Erdmann's researches respecting the amount of sulphur contained in seeds (J. Pr. Chem. XXXIX, 281).

Proximate Constituents of the Animal Body, and Collateral Matters. Protein-Compounds in General. — It is well known that Mulder's directions for preparing a substance containing no sulphur, from albumin, by means of a potassa-solution (protein), have been recently found incorrect. Fleitmann(1) has shown that it is not obtainable even by Mulder's latest method, even if the hydrated teroxide of bismuth be employed; but that the resulting preparation contains 1·35 to 1·48 per cent of sulphur, which can neither be ascribed to an admixture of undecomposed albumin, nor to the presence of free sulphur, nor to a combination of so-called protein with sulphuric acid. Fleitmann found in the preparation obtained from purified albumin, by continued digestion with potassa and hydrated teroxide of bismuth, by filtering and precipitating the filtrate by acetic acid, 53·8 to 54·1 per cent of carbon, 7·1 to 7·3 hydrogen, and 15·9 to 16·2 nitrogen.—Mulder(2), although the assumption and production of a protein without sulphur was the starting point of the entire theory of protein-compounds, has since expressed the opinion that the question as to the existence of such a body need no longer be discussed; that sulphur and phosphorus are contained in the protein-compounds, albumin, the hair, &c., in the shape of a (hypothetical) sulphamide, SNH_2, and a (hypothetical) phosphamide, PNH_2(3), and that an oxide of the (hypothetical) protein may likewise unite with these (hypothetical) amides, and form similar combinations. He considers that the desulphuration does not imply a total removal of sulphur from the albumin, but a decomposition of the sulphamide contained therein, which takes place by means of an assimilation of the elements of water, disengagement of ammonia, and the formation of S_2O_2, which latter substance enters, in variable quantities, into combination with protein, on the addition of an acid; consequently, according to Mulder, albumin may be desulphurised without becoming free of sulphur; the dephosphoration of the albumin must be considered in the same light. He now discovers 1·2 per cent of

Proximate constituents of the animal body and collateral matters. Protein-compounds in general.

(1) Ann. Ch. Pharm. LXI, 121.

(2) Scheik. Ond. IV, 195; Repert. Pharm. [2] XLVII, 1, 145, 289; XLVIII, 1, 145; J. Pr. Chem. XLIV, 488; Chem. Gaz. 1849, 12, 29.

(3) This view is not supported by any determination as to the proportion of the ammonia and the sulphur-acid formed in the decomposition by potassa; and the circumstance that a portion of the sulphur is transformed into sulphide of potassium, militates against it; it has not in any way been demonstrated, that during the decomposition by potassa under exclusion of the atmosphere such acids are formed, as might be expected from the decomposition of such a sulphamide and phosphamide.

Protein-compounds in general.

sulphur in fibrin, and in the so-called desulphurized protein, obtained from it by potassa, 0·72 per cent of sulphur; in the protein obtained from albumin by potassa, 1·6 per cent of sulphur, in a state of combination in which the sulphur does not act upon silver or lead. He describes various experiments, according to which the amount of sulphur is increased in the so-called protein-combinations, when their alkaline solution is submitted to the influence of sulphurous, or hyposulphurous acid. He determines the composition of the hypothetical protein, by subtracting from the composition of the so-called desulphurized body a quantity of $S_2 O_2$, corresponding to the amount of sulphur; thus he arrives at the conclusion that the formula of protein is $C_{36} H_{25} N_4 O_{10} + 2\,HO$. He also attempts to deduce an explanation of the effect produced by potassa and chlorine upon albumin, from his views on the condition of the sulphur, and communicates his opinions on the combinations of protein and albumin, on protoxyprotein, tritoxyprotein, &c.; we may pass them over, as the foundation on which they rest is very insecure. In a treatise on the protein-combinations in the vegetal kingdom(1), Mulder estimates the amount of sulphur in the albumin of wheat at 1·04, of rye at 0·77 per cent. For the details we refer the reader to these treatises themselves, as also to another on the protein of flesh(2), and to a summary of the amount of sulphamide and phosphamide assumed by Mulder in various so-called protein-combinations.(3)

De Vry(4) has stated, that when chlorous acid is made to act upon protein and gelatin, products which are soluble in water, are formed; he obtained none of the compounds mentioned by Mulder, as resulting from the influence of chlorine on solutions of protein and gelatin, and which the latter terms chlorites of protein and of gelatin.

Amount of Sulphur contained in Animal Matter. — When fibrin, albumin, casein, &c., are heated with potassa-solution, a portion of the sulphur combines with the alkali, and forms sulphide of potassium, another portion remains in combination with the organic matter, and in this respect exhibits the same deportment as the sulphur of taurin. Th. Fleitmann(5) has determined the amount of the sulphur removed by dissolving the substance in dilute potassa, digesting for

(1) Scheik. Ond. IV, 404; Arch. Pharm. [2] LV, 187; J. Pr. Chem. XLIV, 503.
(2) Scheik. Ond. IV, 402; J. Pr. Chem. XLIV, 505.
(3) Scheik. Ond. IV, 421; J. Pr. Chem. XLV, 376.
(4) Ann. Ch. Pharm. LXI, 248.
(5) Ibid. LXVI, 380.

six to eight hours with recently precipitated hydrated teroxide of bismuth, supersaturating with acetic acid, and oxidizing the sulphur in the filtered tersulphide of bismuth, by fusing it with potassa and nitrate of potassa. He thus obtained the following averages in 100 parts :

Amount of sulphur contained in animal matter.

	Membrane of egg.	Fibrin.	Crystallin.	Albumin from blood.	Casein.
Total amount of sulphur.	4·14	—	—	—	—
Amount of sulphur removed	2·61	0·52	0·37	1·03	0·07

Spec. Grav. of Animal Matter.—C. Schmidt(1) has determined the spec. grav. of various animal substanees, all of which, when burnt, left an ash. The spec. grav. of the substanees, as directly obtained, are given under A ; he determined the eomposition of the ash, and the spee. grav. of its component parts, and then eorreeted the spec. grav. of the substanees for this ash (the results thus obtained are given under B) ; but his formulæ are incorrect, as he mistook the relation between the spec. grav. of a mixture and of its components. An anonymous writer(2) has direeted attention to this point, and corrected the caleulation (the correetions are given under C).

	A.	B.	C.
Blood-corpuscles . .	1·2507	1·2090	1·239
Fibrin of muscle . .	1·2833	1·2678	1·276
Albumin of hens'-eggs .	1·3144	1·2617	1·286
Tendons	1·3011	1·2960	1·299

The proposition of Schmidt(3) to calculate the amount of albumin and blood-corpuseles by the spec. grav. of the serum and the defibrinized blood, is also based upon incorreet formulæ.

Muscular Tissue of Fish.—Baumhauer(4) has examined the muscular tissue of various fishes. The musele was minutely divided, and kneaded in cold water so long as the latter took up anything ; it was then heated in a larger quantity of water to 80° and 90°, digested in acetic acid, washed with boiling water, dried, treated with aleohol and ether, and dried at a temperature of 120°. On an average 100 parts

(1) Ann. Ch. Pharm. LXI, 156.

(2) Pogg. Ann. LXXI, 129 ; Schmidt's admission of the correction, Ibid. LXXII, 175.

(3) Ann. Ch. Pharm. LXI, 165.

(4) Scheik. Ond. IV, 293 ; Jahrb. Pr. Pharm. XVIII, 51, 129 ; J. Pr. Chem. XLIV, 506.

Muscular tissue of fish.

of muscular tissue of the thunny (*Solea vulgaris N., Pleuronectes solea L.*) yielded 1 per cent of ash, and, after deducting the ash, 53·4 per cent of carbon, 7·15 hydrogen, 15·3 nitrogen; the same of the plaice (*Rhombus barbatus N., Pleuronectes rhombus L.*) 0·40 per cent of ash, and 53·4 carbon, 7·1 hydrogen, 15·3 nitrogen. —The muscular tissue of the haddock (*Merlangus vulgaris; Gadus merlangus L.*) treated as above, but with omission of the acetic acid, yielded 1·25 per cent, and when treated with acetic acid, 1·20 per cent of sulphur. The muscular tissue of the thunny, exhausted by acetic acid, afforded 0·84 per cent of sulphur.—After dissolving the muscular tissue in dilute potassa-ley and precipitating with acetic acid, washing the precipitate with boiling water, alcohol and ether, and drying at 120°, the thunny yielded 54·8 per cent of carbon and 7·0 of hydrogen; the plaice, 54·7 per cent of carbon, 7·1 of hydrogen, and 14·7 of nitrogen; the haddock, from 0·88 to 1·06 per cent of sulphur. Baumhauer has, moreover, investigated the precipitates which are produced by ammonia in hot or boiling solutions of muscular tissue in acetic acid; we are obliged to refer to the treatise for the details of the analysis, as well as for the reactions of the various solutions.

Epithelium of Mucous Membrane.—The free surfaces of the animal body are invested with a more or less thick layer of nucleated cells, which together represent an organized tissue. It has received various names, according to the parts upon which it occurs, and it is known to be non-vascular and non-nervous. On the external surface it is termed *epidermis,* on the inner free surfaces and cavities it is called epithelium.—Scherer(1) has formerly determined the elementary composition of the epidermis; Gorup-Besanez(2) has lately ascertained the composition of the epithelium of the whale, as obtained by scraping the mucous membrane of this animal. Under the microscope it appeared composed of well-developed tesselated epithelia, which do not differ from that of man, either in structure or chemical deportment. After repeated treatment with water, alcohol and ether, drying and pulverizing, it formed a yellowish electrical powder, which was with difficulty soluble in potassa. The alkaline solution gave with acetic acid, a precipitate soluble in an excess of acid; the latter solution was precipitated by ferrocyanide of potassium. Boiling hydrochloric acid produced a blue solution, similar to that of albuminoid substances. Analysis afforded the following results:

(1) Ann. Ch. Pharm. XL, 47. (2) Ibid. LXI, 49.

	Epithelium, according to Gorup-Besanez.	Epidermis, according to Scherer.	Epithelium of mucous membrane
Carbon . . .	51·53	50·34	
Hydrogen . . .	7·03	6·81	
Nitrogen . . .	16·64	17·22	
Oxygen . . .	22·32	25·63	
Sulphur . . .	2·48	not determined.	

Gorup-Besanez does not consider the discrepancy sufficient to establish an essential difference between the two substances.

Casein, Products of Putrefaction.—P. Iljenko(1) has investigated the products of the putrefaction of pure casein prepared from milk. Water being poured over it, it was exposed to the atmosphere during several months in the summer. The volatile products of the decomposition were carbonic acid, sulphuretted hydrogen, ammonia, butyric acid, valerianic acid and a peculiarly smelling, non-acid, oleaginous body, which easily changed when in contact with the atmosphere, or on the addition of acids. It was not obtained in sufficient quantity to be more closely examined. Iljenko and Laskowsky had formerly observed a similar substance in Limburg cheese. The non-volatile products of putrefaction are leucine and casein in a soluble condition. The solubility of the latter is caused by ammonia; leucine and valerianic acid have been proved by Liebig to be also products of decomposition of the casein by fusion with potassa.

Casein. Metamorphosis into Fat.—Blondeau(2) has investigated the changes which Roquefort cheese suffers in the cellars in which it is stored until it acquires the qualities which it is required to have in commerce. Before being stored, it contained only about $\frac{1}{200}$ of its weight of fatty matter; but after being kept for two months, almost all the casein was transformed into a butyroid, readily saponifiable fat, which melts at 40°, boils at 80° and is decomposed at 150°. This transformation was attended by a development of fungi, which were all nitrogenous. Blondeau distinguished *Penicillium glaucum*, *Penicillium globulosum*, *Torvula viridis* and *Torvula aurantiaca*. Fibrin suffered a similar metamorphosis under the same circumstances.

Albumin from Fishes and Fowls.—H. Weidenbusch(3) has examined the albumin of the flesh of the pike and of fowls. The chopped-up meat was macerated in water, the extract boiled, and the

(1) Ann. Ch. Pharm. LXIII, 264.
(2) Compt. Rend. XXV, 360 ; J. Chim. Méd. [3] IV, 80.
(3) Ann. Ch. Pharm. LXI, 370.

Albumin from fishes and fowls.

albumin, after being strained and washed in water, purified with alcohol and ether. The following are the averages of closely accordant analyses :

	Carbon.	Hydrogen.	Nitrogen.	Sulphur.	Oxygen.	Ash.
Albumin of the pike	52·6	7·3	16·5	1·6	21·8	0·2
„ „ „ fowl	53·2	7·0	15·7	1·6	22·3	0·2

Soluble Albumin of Fishes.—Baumhauer(1) has examined the soluble albumin of fishes. The cold aqueous extract of the chopped fish was made to coagulate at 50°, the coagulum was treated with boiling water, alcohol, and ether, and dried at 120°. The preparation thus made of the plaice (*Rhombus barbatus, N.; Pleuronectes rhombus, L.*) contained 1·00 per cent of ash, 1·03 of sulphur, and 0·72 of phosphorus; that made of the haddock (*Merlangus vulgaris; Gadus merlangus L.*) 0·50 per cent of ash, 1·31 sulphur, and no phosphorus. —The coagulum was dissolved in boiling acetic acid, and ammonia added so as to leave an acid reaction; the precipitate (A) was washed with boiling water, alcohol and ether, and dried at 120°; it then contained (of the plaice) 0·37 per cent of ash, 54·4 carbon, 7·0 hydrogen, 15·8 nitrogen, and (of the haddock) 1·5 sulphur.—The coagulum was dissolved in dilute potassa, kept for some time at a temperature of 90°, air passed through it, filtered, and the filtrate precipitated with acetic acid; the precipitate (B) was then treated like the preceding one. It contained (plaice) 0·5 per cent of ash, 54·7 carbon, 7·0 hydrogen, 14·6 nitrogen, and (haddock) 1·1 sulphur. Baumhauer, following Mulder's views, considers the precipitate A as $10\,(C_{36}\,H_{27}\,N_4\,O_{10}) + 4\,(S\,N\,H_2 + HO)$ (2) and the precipitate B as $20\,(C_{36}\,H_{27}\,N_4\,O_{10} + HO) + 3\,S_2\,O_2$.

Vitellin.—The analyses of vitellin by Jones(3), Dumas and Cahours(4), Gobley(5) and Baumhauer(6) had not yielded accordant results. Noad(7) has resumed the analysis of this body. In order to obtain it, the yolk of hard-boiled eggs was carefully separated from the white, twice treated with boiling alcohol, and repeatedly with ether, until the latter no longer became coloured and the vitellin was quite white. On repeating Baumhauer's

(1) Scheik. Onderzoek. IV, 332; J. Pr. Chem. XLV, 120.

(2) As the hypothetical sulphamide just yields ammonia and hydrosulphuric acid by the addition of water ($2\,S\,N\,H_2 + 2\,HO = 2\,N\,H_3 + S_2\,O_2$), the introduction of air is unintelligible.

(3) Ann. Ch. Pharm. XL, 65.

(4) Ann. Ch. Phys. [3] VI, 385; Berzelius' Jahresber. XXIII, 590.

(5) Berzelius' Jahresber. XXVI, 914.

(6) Scheik. Ond. III, 272; Berzelius' Jahresber, XXVII, 674.

(7) Chem. Gaz. 1847, 409.

method of purifying it, which consists in dissolving the vitellin in acetic acid, and precipitating by carbonate of ammonia, he obtained so little precipitate on addition of the latter, that he desisted from this process. In 100 parts of the vitellin, dried at 100°, (when dried at from 130° to 150° it becomes coloured), there were found:

Carbon . . .	53·95	53·85	54·08
Hydrogen . .	7·84	7·71	7·83
Nitrogen . . .	13·02	12·60	—
Sulphur . . .	1·85	1·50	—

On the amount of sulphur contained in vegetal albumin, *see* II. p. 130.

Legumin.—The analyses of legumin by Scherer(1), Jones(2), Dumas and Cahours(3), Rochleder(4), and Rüling(5), differ in their results by more than 4 per cent of carbon, and 3 per cent of nitrogen. Noad(6) has published new analyses of legumin; the results arrived at by him correspond most closely with those of Jones. The legumin was partly obtained from peas and partly from beans; both seeds were soaked in water during twenty-four hours; the fluid, after the starch was deposited, was filtered through linen, the legumin precipitated with sulphuric acid, washed on a filter with distilled water, dissolved in ammonia, filtered, precipitated by acetic acid and washed, digested with alcohol and with ether, and dried. The amount of carbon and hydrogen was determined by combustion with chromate of lead, the nitrogen by heating with soda-lime, the sulphur was not determined; 100 parts yielded:

	From peas.				From beans.		
	dried at 100°	at 100°	at 150°	?	dried at 100°	at 150°	?
Carbon	52·76	52·79	54·40	—	53·57	55·05	—
Hydrogen	7·88	7·89	7·53	—	7·79	7·59	—
Nitrogen	—	—	—	15·94	—	—	15·26

Norton(7) arrived at other results in reference to the composition of legumin. He prepared it out of the meal of common green peas and sweet almonds that had been well crushed. These substances were rubbed up with water, much water was added, filtered through linen

(1) Ann. Ch. Pharm. XL, 1; Berzelius' Jahresber. XXII, 276.
(2) Ann. Ch. Pharm. XLI, 65; Berzelius' Jahresber. XXII, 276.
(3) Ann. Ch. Phys. [3] VI, 385; Berzelius' Jahresber. XXIII, 591.
(4) Ann. Ch. Pharm. XLVI, 155; Berzelius' Jahresber. XXIV, 459.
(5) Ann. Ch. Pharm. LVII, 301.
(6) Chem. Gaz. 1847, 357.
(7) Sil. Am. J. [2] V, 22.

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after from twelve to sixteen hours, and subsequently several times through paper; the filtrate was precipitated by acetic acid, the precipitate washed, dissolved at a moderate temperature in dilute ammonia (the higher the temperature and the more concentrated the ammonia, the darker was the colour), filtered, the filtrate again precipitated by acetic acid and the precipitate repeatedly exhausted with alcohol and with ether. Below will be found the averages of analyses, which agree well; the calculations are made for 100 parts, after deducting the ash. 1. is legumin from almonds, dried at 130°, which before being boiled with ether and with water, was dissolved in strong ammonia; it was almost white, and contained 0·17 per cent of ash. 2. is legumin from almonds, which had been boiled in alcohol and in ether before being dissolved in a strong solution of ammonia; it was dark, and contained 0.35 per cent of ash. 3. is legumin from almonds, which, after precipitation with acetic acid, was only boiled in alcohol and in ether, and had not been dissolved in ammonia; it was white, and contained 0·55 of ash. 4. is legumin from peas, which, before being boiled in alcohol and in ether, was dissolved in ammonia; it was almost white, and contained 0·77 per cent of ash. 5. is legumin from peas, which, after boiling in alcohol and in ether, was dissolved in ammonia; it contained 1·23 per cent of ash.—Legumin from almonds and peas is easily soluble in cold water, and on the addition of a small quantity of hydrochloric or acetic acid, a copious precipitate takes place; on boiling a solution of the former a similar deportment is observed, whereas when a solution of the latter is boiled, no precipitate is formed; both are soluble in ammonia; the solution of the former is precipitated by acetate of lead, that of the latter is only rendered turbid.—A small quantity of a similar substance is found in oats; it may be extracted by water, but it is not at once precipitated by dilute hydrochloric and acetic acids, but only gradually, nor does it at once afford a precipitate on boiling, but only as it cools; it is soluble in ammonia and is precipitated by acetate of lead. This substance, for which Johnston proposed the term *avenin*, exhibited the composition given under 6. after deducting the ash, of which it contained 0·75 per cent. After extracting the avenin from the oats, these yielded a brown solution with dilute ammonia, which was filtered and precipitated with acetic acid. The light-brown precipitate, when dissolved in dilute ammonia, again precipitated with acetic acid and boiled in alcohol and in ether, afforded, after subtracting the ash, the composition 7.; it was brownish-white, and contained 0·86 per cent of ash; but when the solution in ammonia was boiled with alcohol and with ether, it exhibited the composition given under 8.; it then equally contained

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0·86 per cent of ash, but was of a lighter colour than the previous precipitate. The nitrogen was determined according to Dumas', the phosphorus according to Berthier's method; the sulphur was determined by oxidation by means of heating the substance with caustic soda.

	1.	2.	3.	4.	5.	6.	7.	8.
Carbon . . .	50·50	50·97	49·16	50·72	50·57	52·36	53·27	51·82
Hydrogen . .	6·56	6·64	6·51	6·56	6·90	6·85	6·94	6·86
Nitrogen . . .	17·33	17·15	17·43	15·77	16·84	14·76	16·81	16·39
Oxygen . . .	24·24	24·40	24·27	23·87	23·70	24·16	21·56	22·82
Sulphur . . .	0·32	0.27	0·41	0·77	0·33	1·06	0·59	1·11
Phosphorus . .	1·05	0·57	2·21	2·31	1·66	0·81	0·83	1·00

Norton adopts Mulder's opinion (II. p. 129), that the phosphorus and sulphur are to be deducted from the composition of the above-named substances, and that the legumin of the peas and the avenin must be considered as oxide of protein.

Gelatin.—Hunt(1) has proposed to adopt the formula $C_{24}H_{20}N_4O_8$ for the composition of gelatin, which he assumes to be an amidoid combination of cellulose or starch $2\,(C_{12}\,H_{10}\,O_{10}) + 4\,NH_3 - 12\,HO = C_{24}\,H_{20}\,N_4\,O_8$. — —

Glycocoll.—Laurent(2) has expressed the opinion that glycocoll (gelatin-sugar, $C_4\,H_5\,N\,O_4$) may be considered as an amidogen-acid, the acid which Horsford obtained by treating glycocoll with oxidizing agents, and which he considered as composed according to the formula $C_3\,H_3\,O_6$ (when united with baryta), but for which Gerhardt had proposed the formula $C_4\,H_3\,O_5$ (NH_4O, $C_4\,H_3\,O_5 - 2\,HO = C_4\,H_5\,N\,O_4$). Laurent proposes the term glycolic acid for the latter acid; the glycocoll would then be termed glycolamic acid.

When glycocoll is dissolved in concentrated nitric acid and treated with nitric oxide gas, Strecker(3) states that a non-nitrogenous acid is formed, the composition of which he assumes as $C_4\,H_4\,O_6$ (as hydrate). This appears to be the acid which has just been termed glycolic acid.

Hunt(4) has observed that according to Gerhardt's assumption regarding the composition of cacodylic acid (alkargene), a simple relation exists between this compound and glycocoll, the former containing arsenic in the place of the nitrogen of the latter.

(1) Sill. Am. J. [2] V, 74; VI, 259.
(2) Ann. Ch. Phys. [3] XXIII, 110; J. Pr. Chem. XLV, 168.
(3) An . Ch. Pharm. LXVIII, 55.
(4) Sill. Am. J. [2] IV, 266; Chem Gaz. 1847, 386.

Leucine.

Leucine.—According to Gerhardt and Laurent,(1) the composition of leucine is $C_{12}\,H_{13}\,N\,O_4$; it contains one equiv. of hydrogen more than Mulder calculated. The nitric acid combination is $C_{12}\,H_{13}\,N\,O_4$, NO_5, HO; the hydrochloric acid compound $C_{12}\,H_{13}\,N\,O_4$, HCl. Leucine belongs to the same series as glycocoll and sarcosine:

$C_2\,H_3\,N\,O_4$	—
$C_4\,H_5\,N\,O_4$	glycocoll
$C_6\,H_7\,N\,O_4$	sarcosine
$C_8\,H_9\,N\,O_4$	—
$C_{10}\,H_{11}\,N\,O_4$	—
$C_{12}\,H_{13}\,N\,O_4$	leucine.

According to Liebig, leucine, when fused with potassa, yields valerianic acid, ammonia and hydrogen; sarcosine ought, therefore, to yield acetic acid, while glycocoll should give formic acid.

Cahours(2) has at the same time, with the above chemists, confirmed Mulder's statement that Braconnot's aposepedin, or Proust's caseous oxide, is nothing but leucine. He gives the same formula for it as Laurent and Gerhardt(3). He also pointed out that thialdine may be viewed as leucine, in which oxygen is replaced by sulphur (leucine $= C_{12}\,H_{13}\,N\,O_4$, thialdine $= C_{12}\,H_{13}\,N\,S_4$).

Products of the Decomposition of Casein, Albumin, Fibrin, and Gelatin.—The decomposition of gelatin by bichromate of potassa and sulphuric acid had been examined by Schlieper(4) in 1846. Guckelberger(5) has recently carried out comprehensive investigations upon the products of decomposition of casein, albumin, fibrin and gelatin, when acted upon by peroxide of manganese and chromic acid with the co-operation of sulphuric acid.

Casein with peroxide of manganese and sulphuric acid.—The casein was obtained by the coagulation of skimmed milk, washing and straining the curds, and transferring them to a dilute solution of carbonate of soda, heated from 60° to 80°. They were allowed to stand at this temperature for several hours, the skin was removed as it formed, the slightly turbid fluid was precipitated with dilute

(1) Compt. Rend. XXVII, 256; Ann. Ch. Phys. [3] XXIV, 321; J. Pharm. [3] XIV, 311.

(2) Compt. Rend. XXVII, 265; J. Pr. Chem. XLV, 350; Ann. Ch. Pharm. LXVIII, 364.

(3) Mulder's (Scheik. Ond. V, 371) renewed statement, that leucine contains only 12 eqs. of hydrogen, is not correct; new analyses made by Strecker in the Giessen laboratory have proved it to contain 13 eqs. of hydrogen.

(4) Ann. Ch. Pharm. LIX, 1; Berzelius' Jahresber. XXVII, 646.

(5) Ann. Ch. Pharm. LXIV, 39; Chem. Gaz. 1848, 89, 114; J. Pharm. [3] XIII, 130.

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sulphuric acid, the coagulum, as it formed, repeatedly stirred up with hot water, and strained. The casein thus prepared exhibited mere traces of fat, so that no farther purification was requisite. One part of this casein was carefully pulverized, and then introduced into a mixture of $4\frac{1}{2}$ parts of concentrated sulphuric acid, with 9 of water, which had been allowed to cool to from 40 to 50°; after a few hours complete solution had taken place, and the trifling remainder of fat floated on the surface, and could be easily removed. On the following day, the solution, diluted with 10 parts of water, was well mixed in the distilling apparatus with 3 parts of manganese, 11 parts of water added, and distilled. The retort must be of glass, and only half filled, in order to avoid the possibility of the mixture rising over. The distillate that first passes over possesses a peculiar pungent odour, which afterwards becomes milder, and at last approaches to that of hydrocyanic acid, or oil of bitter almonds; still the presence of hydrocyanic acid could not be proved in the liquid. The distillate was shaken up with carbonate of lime, in order to separate the acid constituents, and about one half of the neutral fluid was distilled over.

This distillate, which contained the *non-acid products*, was neutral, but soon became acid on exposure to the atmosphere; on being repeatedly rectified, a milky fluid was at last obtained, on which a layer of light, yellow oil, of a pungent odour, floated; after a time, the milky fluid that was separated from this lighter oil, yielded a few drops of a heavier oil, which, on exposure to the atmosphere, were converted into a white crystalline mass. Careful rectification of the lighter yellow oil in the water-bath, yielded the following substances. At a temperature of 40° — 50°, a fluid passed over, from which the *aldehyde of acetic acid* ($C_4 H_4 O_2$; observed boiling-point from 23° to 28°, spec. grav. 0·796 at 15°), and its ammonia-compound were obtained.—Between 65° and 70°, a distillate passed over, which, on being deprived of its water by chloride of calcium, presented a boiling-point that varied from 40° to above 70°; that which now distilled between 50° and 70°, did not yet present a constant boiling-point; that which passed over in the last rectification between 55° and 60°, was a colourless, odorous, ethereal fluid, of 0·79 spec. grav. at 15°, miscible with water, alcohol, and ether, in every proportion; it was neutral, but on exposure to the atmosphere, it became slowly acid, more rapidly, however, when in contact with platinum-black; it was not altered by potassa, nor did it form a metallic mirror with nitrate of silver; its composition agreed with that of the *aldehyde of metacetonic acid*, $C_6 H_6 O_2$, and the density of its vapour (observed 2·17, calculated 2·01) corresponded

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to this formula, on the assumption of a condensation to 4 vols. The acid formed with platinum-black was lost; the deportment, above-noted, with potassa and solution of silver, does not correspond to that generally observed in aldehydes, nor could a combination with ammonia be obtained.—The fluid remaining in the retort now exhibited two layers, the lower one aqueous, the upper one yellow and oily. At 100° a colourless oil, almost insoluble in water, distilled over, being the *aldehyde of butyric acid*, $C_8 H_8 O_2$, with a boiling-point between 68° and 73°, spec. grav. 0·8 at 15°, of an ethereal pungent odour, and burning taste. This fluid mixes with alcohol and ether in all proportions, is coloured brown with caustic potassa, and blood-red with concentrated sulphuric acid. With aqueous ammonia it forms an insoluble crystalline compound, which is almost insoluble in water, and appears, when viewed under the microscope, in the form of acute rhombic octohedrons. When the alcoholic, or ethereal solution, is allowed slowly to evaporate, it may be obtained in the shape of tolerably large tabular crystals, the composition of which is $NH_3, C_8 H_8 O_2 + 10\,HO$. This remains unchanged when exposed to a dry atmosphere, but in moist air it becomes brown; when heated slowly it melts, without disengagement of ammonia; when heated more strongly it boils, and deposits droplets on the cooler portions of the vessel, which solidify in the cold; when rapidly heated, ammonia is at once evolved; potassa causes no disengagement of ammonia in the cold; when warmed with a solution of silver a metallic mirror is formed; when sulphuretted hydrogen is made to act upon the alcoholic solution, a base is formed, which is probably analogous to thialdine. If, after dilution with water, a concentrated cold solution of alum be added, so as to cause an acid reaction, and the whole be distilled, the ammonia-compound yields a fluid, upon which the body $C_8 H_8 O_2$, floats isolated and pure. This latter substance, when exposed to the atmosphere, and immediately on boiling with protoxide of silver, yields butyric acid; it is distinguished from the body described by Chancel(1) as *butyral*, and obtained by dry distillation from butyrate of lime, with which it is isomeric, as proved by its deportment with ammonia, and by its boiling-point. The residue of the fluid to be rectified, when still farther heated (over an open fire), at first yielded some more of the preceding substances, and at last drops, which sank in water; their identity with oil of bitter almonds was incontestably proved, their boiling-point being from 180° to 183°, and their spec. grav. 1·038 at 15°;

(1) J. Pharm. [3] VII, 113; Berzelius' Jahresber. XXV, 803.

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the oil of bitter almonds, as well as the benzoic acid that was formed from it, was analysed.

In order to discover the *acids*, the residuary fluid, after distillation of the non-acid products, which contained the lime-salts of these acids, was partially evaporated, precipitated by carbonate of soda, and the filtrate (a solution of the soda-salts) evaporated in the water-bath, to the consistence of a thin syrup. As the liquor cooled, a copious crystallization of *acetate* of soda followed; the mother-liquor, on being still farther evaporated at a moderate temperature, yielded more crystals, which, for the most part, consisted of acetate of soda, intermixed with tabular crystals of another soda-salt, which was insoluble in spirit of wine, and the acid of which proved to be *formic acid*. The mother-liquor of the last crystallization was treated with dilute sulphuric acid (1 part concentrated acid to 2 parts water) and allowed to stand for a day; a brownish oil was perceived to separate above the aqueous solution of sulphate of soda, this was shaken up with an equal volume of water, in order to separate the more soluble butyric from the valerianic acid, which was recognisable by its odour; the wash-water, and the aqueous solution of sulphate of soda were mixed, saturated with carbonate of soda, evaporated in the water-bath to dryness, and decomposed by dilute sulphuric acid; thus an almost colourless oil was obtained. The latter commenced boiling at a little above 100^0; the fluid that passed over between 100^0 and 130^0, when saturated with ammonia, and mixed, while boiling, with nitrate of silver (metallic silver being deposited), yielded, on cooling, the double-salt of acetate, and metacetonate of silver. At 130^0 the boiling-point was constant for some time, and what passed over between 130^0 and 140^0 was proved to be *metacetonic acid;* between 160^0 and 165^0 *butyric acid* passed over. The residue was mixed with the distillate of the previously mentioned brownish acid (towards the close of the distillation of the latter, a white crystalline substance was perceived in the neck of the retort, which was found to be *benzoic acid*), the whole was saturated with baryta, and allowed to evaporate over sulphuric acid; at first, *caproate* of baryta crystallized out in hemispherical bunches, the *valerianate* of baryta then appeared in nacreous plates, and finally came *butyrate* of baryta in concentrically grouped transparent columns.

Casein with bichromate of potassa and sulphuric acid.—It is advisable to dissolve 1 part of casein in 3 parts of sulphuric acid, diluted with 6 of water, to add this fluid to a solution of 2 parts of bichromate of potassa in 20 of water, and to moderate the lively reaction which ensues, by adding 4 parts more of water; the distillation then proceeds quickly, and without overflowing. The distillate

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possesses a deadening, prussic acid odour, and tastes of *aqua laurocerasi;* its reaction is acid, and it is rendered turbid by numerous white flocks. It contains a large amount of prussic acid, and no aldehyde; in order to remove the prussic acid, it was shaken up with protoxide of mercury, and rectified; this did not, however entirely remove the odour of prussic acid. The distillate thus obtained was neutralized with carbonate of lime, and rectified, by which means a turbid, aqueous distillate was obtained, on the surface of which there floated a layer of colourless oil. The rectification of the turbid, aqueous layer yielded some more of this oil, and upon its separation the prussic acid odour had disappeared; the residue in the retort was almost milk-white, and possessed an odour resembling that of oil of cinnamon, and belonging to a substance which was deposited in the cold as a heavy, colourless oil. The quantity obtained was too small to be closely examined; it turned yellow on the application of concentrated sulphuric acid, and on the addition of potassa to this mixture, it assumed a dark-purple colour.

When the lighter, colourless oil, which was dried with chloride of calcium, was distilled, ebullition ensued below 70°, but the boiling-point was not constant until 120° — 130°. The fluid which distilled over below 90°, yielded, on repeated rectification, and by separately receiving what passed over, first, a substance which boiled at from 55° to 60°; this was found to be identical with the substance $C_6 H_6 O_2$, which has been spoken of at II. p. 139.—The greater part of the fluid, distilled at from 120° to 140°, consisted of a nitrogenous substance, which was rendered colourless and pure by repeated rectification, that which passed over at the commencement and termination of the process being in every instance removed. It then exhibits a boiling-point of 125° to 128°, the spec. grav. 0·813 at 15°, and the composition $C_{10} H_9 N$; the density of the vapour = 2·892; under the assumption of a condensation to 4 volumes it is calculated at 2·877; it possesses a smell of bitter almonds, an aromatic, bitter, pungent taste; it is soluble in 4 times its volume of water, and in all proportions in alcohol and in ether; it burns with a white sootless flame; it evolves ammonia when treated with potassa; if the alkaline fluid is then super-saturated with sulphuric acid, oil-globules are separated, which, when distilled, are very acid, and have the odour of valerianic acid. Valerianic acid is also formed, if this substance be directly distilled with sulphuric acid. This nitrogenous compound is consequently identical with *valeronitrile* obtained by Schlieper(1), by the decomposition of gelatin with chromic acid.

(1) Ann. Ch. Pharm. LIX, 15; Berzelius' Jahresber. XXVII, 649.

Products of the decomposition of casein, albumin, fibrin, and gelatin.

It seemed probable that in that portion of the fluid used for the preparation of valeronitrile, which had a boiling-point above 128°, there was a small quantity of *oil of bitter almonds*.

The acids produced in addition to *prussic acid*, were isolated, as stated at II. p. 141; after the removal of the prussic acid by protoxide of mercury, a small quantity of the latter was reduced, and proved the presence of *formic acid*. Before the soda-salts were evaporated to a syrup, a copious amount of *benzoic acid* was precipitated by dilute sulphuric acid; the liquid being again saturated with carbonate of soda, and evaporated to a syrup, at first a large quantity of *acetate* of soda crystallized; from the mother-liquor *valerianic* and *butyric acids* were separated.

Guckelberger institutes a comparison between the products of the action upon casein of peroxide of manganese with sulphuric acid, and of chromic acid. He shows, that in both cases the influence is more similar than it appears at first sight, and that the difference chiefly depends upon the circumstance, that when peroxide of manganese is employed the *acids*—f. i. formic and valerianic acids —appear; while when bichromate of potassa and sulphuric acid are used, the *nitriles of these acids* are produced; it may be observed, that hydrocyanic acid may be viewed as formonitrile, $NH_4O, C_2HO_3 - 4HO = HC_2N$. In the former case, the residue of the distillation evolves, on being saturated with lime, a large quantity of ammonia; in the latter, scarcely a trace of ammonia is obtained in the same manner.

Albumin, fibrin, and gelatin with peroxide of manganese and sulphuric acid.—The fibrin which was obtained from freshly-drawn blood, was washed with cold water until this ran off colourless, hot water was then poured over it a few times, and the mass well squeezed; lean horse-flesh, which had repeatedly been macerated, and at last boiled in water, yielded the same products.—The albumin was prepared from blood which had been freed from fibrin by beating; the blood-corpuscles were separated by a concentrated solution of sulphate of soda, and the filtrate, which was scarcely tinged red, was heated to coagulation; the coagulum was squeezed out, hot water repeatedly poured over, and expressed.—The gelatin was one of the better qualities of commercial glue. The proportions, and the proceedings generally, were the same as those given in reference to casein.

The distillates of these substances with peroxide of manganese and sulphuric acid, could not be distinguished by their odour from those obtained with casein, nor from one another. They all presented an

Products of the decomposition of casein, albumin, fibrin, and gelatin.

acid reaction, and contained no prussic acid. The following substances were found to be present: *aldehyde of acetic acid* to a small amount (not at all with gelatin), the substance $C_6H_6O_2$ above (p. 139) spoken of, *aldehyde of butyric acid* (most copious with fibrin), *oil of bitter almonds, formic* and *acetic acids* (predominating as compared to the other constituents), *butyric acid* (chiefly with fibrin), *valerianic acid* (chiefly with gelatin), and *benzoic acid* in a small quantity.

Albumin, fibrin, and *gelatin,* yielded the same products with *bichromate of potassa* and *sulphuric acid,* as casein. The distillates contained a large amount of prussic acid; benzoic and acetic acids were most copious; the fibrin yielded more butyric acid than the albumin, and even than the casein.

Urea.—Millon(1) has discovered that the residue after drying the *Humor vitreus* of bulls' eyes (which amounts to 1·63 per cent of the fluid) contains 20 to 35 per cent of urea, and appears to contain only chloride of sodium besides. The *Humor vitreus* of the human and the dog's eye is similarly constituted; the *Humor aqueus* also contains urea, and chloride of sodium.—Wöhler(2) succeeded in positively demonstrating the presence of urea in the *Humor vitreus* of fifty calves' eyes.

In reference to the preparation of urea, *see* I. p. 365, on its formation from fulminate of copper-ammonia, when treated with sulphuretted hydrogen, *see* I. p. 374.

Pelouze(3) had discovered that nitrate of urea, on being heated to 140°, disengages a mixture of gases consisting of 1 vol. of nitrogen to 2 vols. of carbonic acid, nitrate of ammonia and urea being left; when the temperature is raised still farther, the nitrate of ammonia is decomposed into protoxide of nitrogen and water, the urea forming carbonate of ammonia, but instead of cyanuric acid, only a small quantity of another difficultly soluble acid, the composition of which is probably $C_2H_3N_2O_4$. Wiedemann(4) found that when the fused nitrate of urea was heated to 152°, much carbonic acid and protoxide of nitrogen, with vapours of carbonate of ammonia, are suddenly evolved; at the same time, the temperature, after the removal of the source of heat, rises to nearly 200°, and in the residue there is an acid besides

(1) Compt. Rend. XXVI, 121. (2) Ann. Ch. Pharm. LXVI, 128.

(3) Ann. Ch. Phys. [3] VI, 65; Berzelius' Jahresber. XXIII, 642.

(4) Dissertatio de novo quodam corpore ex urea producto, Berol. 1847; Pogg. Ann. LXXIV, 67; J. Pr. Chem. XLIII, 271; Ann. Ch. Pharm. LXVIII, 324. An earlier communication of the results: Berl. Acad. Ber. 1847, 223; J. Pr. Chem. 255.

Urea.

the nitrate of ammonia (in weight about $\frac{1}{20}$ of the nitrate of urea employed), which he recognized, both by its composition and reactions, as cyanuric acid. He also examined the salt of this acid, which is obtained as a violet precipitate, by precipitating an ammoniacal solution of protoxide of copper with a solution of cyanuric acid; the composition proved to be $CuO, NH_4O, HO + C_6N_3O_3$, according to the view hitherto adopted regarding the constitution of cyanuric acid; it is $CuO, NH_4O, C_6HN_3O_4$, according to the view of Wöhler given I. p. 375. If the above residue be dissolved in hot water containing nitric acid, a portion of the cyanuric acid crystallizes as the fluid cools; if the other portion be precipitated from the mother-liquor by basic acetate of lead, the excess of oxide of lead removed from the fluid by sulphuretted hydrogen, and the filtrate evaporated to a degree of concentration, at which the nitrate of ammonia does not crystallize, a small quantity of a white crystalline body forms, which Wiedemann designates as *biuret*. This may be more easily and copiously prepared by heating urea for a long time to from 150° to 170°; the pasty mass is to be boiled with a small quantity of water, filtered, the filtrate precipitated with basic acetate of lead, again filtered, the fluid separated from the protoxide of lead by sulphuretted hydrogen, boiled, and evaporated to crystallization. The biuret is easily soluble in water and alcohol; it crystallizes out of the former with the composition $C_4H_5N_3O_4 + 2HO$ (the water escapes in dry air, or at 100°), out of the latter, anhydrous. It dissolves, without decomposition, in concentrated sulphuric acid, and in not too concentrated nitric acid. Its solution is not precipitated by metallic salts, nor by tannic, or gallic acid. It forms a red solution with protoxide of copper and potassa, from which a crystallized compound, which has not as yet been closely examined, may be obtained. When heated it fuses, evolves ammonia, and then solidifies into cyanuric acid. Its formation, from urea, may be explained by assuming that 2 equivs. of urea lose 1 equiv. of ammonia. Wiedemann designated it as biuret, in reference to Berzelius' opinion that urea is a combination of 1 equiv. of urenic oxide (C_2HNO_2), with 1 equiv. of ammonia; in which case the biuret may be considered as a combination of 2 equivs. of urenic oxide with 1 equiv. of ammonia. Wiedemann, also, proved the biuret not to be cyanurate of urea, by preparing this compound, according to Kodweifs'(1) directions, by boiling a solution of urea with cyanuric acid; he found it to be composed according to the formula $C_8H_7N_5O_8$.

(1) Pogg. Ann. XIX, 1.

Urea.

Wurtz(1) considers the combinations $C_4 H_6 N_2 O_2$ (comp. II. p. 10), and $C_6 H_8 N_2 O_2$ (comp. II. p. 19 and 20), as homologous to urea ($C_2 H_4 N_2 O_2$), from which they differ in composition by $C_2 H_2$, or a multiple of this quantity. Laurent(2) expresses himself against this view, inasmuch as he contends that to establish homology, there must also be an analogy of the products of decomposition. Now this analogy is actually observed, as will be shown in our next Report.

Animal Chemistry. Composition of the Hen's-egg.—Gobley has continued(3) the investigations into the nature of the hen's-egg, the former results of which he had published in 1845(4); he considered the objections raised by Sacc(5), and pursued the comparison of the yolk with the cerebral substance. We give the conclusions of this extensive investigation, which Gobley himself arrives at. The fat of the yolk consists, as assumed in Gobley's former treatise, of two distinct substances—a fatty oil, or egg-oil, and a soft, infusible body, which he designates the viscous substance; the latter is the exclusive seat of phosphorus. Oleic acid, margaric, phospho-glyceric, lactic acids, and so-called extract of flesh, are component parts of the yolk, and not products of oxidation formed during the analysis. The viscous substance is not, as Gobley formerly assumed, a compound of oleic, margaric, and phospho-glyceric acids with ammonia, but a compound body, from which two constituents can be obtained, one of which Gobley terms, provisionally, the phosphorus-body, while the other is called the cerebric substance. The phosphorus-body, which during the development of the animal forms the substance discovered by Frémy(6), in his investigations on cerebral fat, and termed phospho-oleic acid, is decomposed by acids and alkalies, under the influence of water or alcohol, and without the co-operation of oxygen, so as to form oleic, margaric, and phospho-glyceric acid. Phospho-oleic acid exhibits the greatest analogy with this phosphorus-body, and under the circumstances just detailed, yields, though with more difficulty, the acids which have just been enumerated as products of decomposition. The cerebric substance resembles, if it be

(1) Loc. cit. II, p. 10.
(2) Compt. Rend. XXVII, 257.
(3) Instit. 1845, 387; Berzelius' Jahresber. XXVI, 912.
(4) J. Pharm. [3] XI, 409; XII, 5.
(5) Compt. Rend. XXII, 649.
(6) Ann. Ch. Phys. [3] II, 463; Berzelius' Jahresber. XXII, 551.

not identical with, the compound termed by Frémy(1) cerebric acid. Gobley gives the following numbers, the results of his former and recent investigations, as expressive of the composition of the yolk. In 100 parts: Composition of the hen's-egg.

Water	51·486	Cerebric substance	0·300
Vitellin	15·760	Chloride of ammonium	0·034
Margarin and olein	21·304	Chloride of sodium, chloride of potassium, and sulphate of potassa	0·277
Cholesterin	0·438		
Phosphorus-body (viz. 7·226 oleic and margaric acid, and 1·200 phospho-glyceric acid).	8·426	Phosphate of lime and magnesia	1·022
		Alcoholic extract, or flesh-extract	0·400
		Colouring matter, traces of iron, and lactic acid	0·553

Winckler(2) had obtained milk-sugar from albumin of eggs, which remained unusually thin after boiling. Budge(3) states that the white of hen's-egg, after addition of alcohol, and filtering, always shows the presence of sugar, on the application of Trommer's test.

Chemical Processes attending the Development of the Animal in the Egg.—Baudrimont and Martin-Saint-Ange(4) have instituted a comprehensive investigation into the chemical processes occurring in the embryonic development of birds and batrachia; we confine ourselves to giving the purely chemical part of the conclusions of the authors. The weight of eggs hatched in the air diminishes during incubation. Respirable air, containing a certain amount of moisture, and a suitable temperature, are necessary for their development. The eggs which are hatched in the atmosphere absorb oxygen, and at the same time give rise to the elimination of water, carbonic acid, nitrogen, and a compound of sulphur, which has not been minutely examined. The loss of weight sustained by the eggs, is less than the weight of the water, of the carbonic acid and nitrogen eliminated, and even less than that of the water, the nitrogen, and the carbon in the carbonic acid, so that we may assume that the oxygen of the latter is derived from the air, and that besides, oxygen is absorbed by the egg from the atmosphere. The oxygen necessary in incubation is consumed in two ways: one portion serves for the formation of carbonic acid, another is absorbed, or serves to form

(1) Loc. cit. II. p. 146, sub. (6).

(2) Repert. Pharm. [2] XLII, 46; Berzelius' Jahresber. XXVII, 677.

(3) Ann. Ch. Pharm. LXIV, 127; the editors of this periodical remark, that this test, alone, does not prove the existence of milk-sugar.

(4) Ann. Ch. Phys. [3] XXI, 195.

Chemical processes attending the development of the animal in the egg.

water. The volume of absorbed oxygen is almost equal to that transformed into carbonic acid; the volume of nitrogen is about half that of the latter. The amount of fat in the egg is diminished during incubation; finally, the nitrogenous constituent suffers decomposition, as proved by the evolution of nitrogen. The egg that has been incubated contains more oxygen than one that has not been incubated. The inorganic constituents of animals may differ very much at different periods of their existence, in kind and relative proportions.

Experiments have been communicated by A. S. Taylor,(1) to disprove the notion that during the development of the chick in the egg, chemical elements are newly generated which were not previously present.

Respiration.—Regnault, Reiset, and Millon(2) have joined to examine more closely the respiration and nutrition of animals. Regnault and Reiset have charged themselves with the study of the respiratory process; they have invented a more accurate method for analysing gaseous bodies, and have communicated the following details on the process of respiration.(3) They employed a very ingenious apparatus, in which an animal could be preserved for some time, and in which the carbonic acid, produced by the respiration, is at once absorbed, and the oxygen consumed constantly replaced by a fresh supply. Thus the quantity of the expired nitrogen, and whatever alterations the air surrounding the animal suffered, with exception of the change of oxygen into carbonic acid, accumulated, and could be more easily determined. They also find, that in the respiratory process a small (much smaller though than was stated by former observers), and variable quantity of nitrogen is exhaled, beyond what is contained in the respired air. This portion is given in the table under the heading, 'nitrogen evolved.' The air which was analysed after the termination of the experiment, was found to contain hydrogen and hydrocarbons in a very minute quantity. In one experiment only, the quantity of the former which had been evolved amounted to 2 litres; in this case, the experiment was made with a dog, which had received a double ration of meat before the experiment, and was attacked with vomiting at its commencement. The following are the results given by Regnault and Reiset:

(1) Guy's Hosp. Rep. VI, 1 (1848); Schmidt's Jahrb. der ges. Medicin LXI, 149.

(2) Compt. Rend. XXVI, 4; J. Pr. Chem. XLIII, 166.

(3) Compt. Rend. XXVI, 17; J. Pr. Chem. XLIV, 50; Instit. 1848, 19; J. Pharm. [3] XIII, 81 (in abstr.) The complete treatise did not appear till 1849 (Ann. Ch. Phys. [3] XXVI, 299.

	Young full-grown dog.			Older dog.
Weight of the animal (all the weights in grammes)	6390	6390	6390	6213
Duration of the experiment in hours	24½	22¼	21¼	27
Oxygen consumed	182·288	182·381	146·479	170·520
Carbonic acid formed	185·961	188·050	150·406	173·472
Oxygen contained in carbonic acid	135·244	136·763	109·386	126·161
Nitrogen evolved	1·182	0·624	1·015	0·530
Weight of oxygen consumed = 100:				
Oxygen in the carbonic acid formed	74·191	74·987	74·677	73·986
Oxygen consumed otherwise	25·809	25·013	25·323	26·014
Nitrogen evolved	0·055	0·342	0·693	0·311
Oxygen consumed on an average in the hour	7·44	8·196	6·893	6·315

	Rabbit.	Fowl.	Young full-grown dog. *	**
Weight of animal	2755	1280	6390	6390
Duration of experiment in hours	42¾	63	21	22⅔
Oxygen consumed	116·291	85·423	168·350	147·454
Carbonic acid formed	146·490	107·232	178·425	152 359
Oxygen contained in carbonic acid	106·538	77·987	129·763	110·806
Nitrogen evolved	0·577	1·251	0·328	0·436
Weight of consumed oxygen = 100:				
Oxygen in carbonic acid formed	91·613	91·295	77·079	75·146
Oxygen consumed otherwise	8·387	8·705	22·921	24·854
Nitrogen evolved	0·495	1·464	0·195	0·296
Oxygen consumed on an average in the hour	2·720	1·356	8·012	6·507

* The air in which the animal respired contained 47 per cent of oxygen.
** The air contained 60 per cent of oxygen.

The animals appeared to exist without inconvenience in the air containing more oxygen; in the respiration of small animals, f. i. birds, in pure oxygen, the deviations from the results obtained in normal respiration were inconsiderable; the same was the case when the air respired contained 79 parts of hydrogen and 21 of oxygen.

R. F. Marchand(1) also has described experiments which serve to prove a trifling elimination of nitrogen in breathing; in these experiments the animals likewise respired in a vessel, in which the carbonic acid was absorbed as soon as formed and replaced by a fresh supply of oxygen. Marchand observed that a guinea-pig, weighing 570

(1) J. Pr. Chem. XLIV, 4.

Respiration.

grms., expired on an average, 0·77 grm. of carbonic acid in an hour, and that with this animal, on an average, 290 parts by weight of inhaled oxygen correspond to 100 parts of carbon, exhaled in the shape of carbonic acid; 109 vol. of inhaled oxygen and 0·94 of evolved nitrogen to 100 vol. of exhaled carbonic acid; lastly, that 0·75 parts by weight of nitrogen correspond to 100 parts by weight of oxygen; he found that the common pigeon, of a volume of 340 cub. cent., exhales, on an average, in the hour, 0·7 grm. carbonic acid, and inhales 0·666 grm. oxygen, and that 100 vol. of exhaled carbonic acid correspond to 0·85 vol. of nitrogen, and 100 vol. of inhaled oxygen to 0·66 vol. of nitrogen evolved. The detailed results of his investigation are given in the following tables; the gas-volumes are expressed in cub. cent. and reduced to 0^0 and 760^{mm} bar.

	A guinea-pig weighing about 570 grm.							Two guinea-pigs			Common pigeon.		
Volume of animal	715	715	715	715	715	715	715	1225	1225	1225	340	340	340
Duration of expt. (hours) . .	9	10	8	15	16	12	16	10	12	10	10	15	10
Nitrogen evolved (vol.) . . .	23·2	34·8	34·4	40·5	54·4	64·2	54·8	66·3	70	62·7	37	41·8	26·2
For 100 vol. expired carbonic acid there is evolved:													
Nitrogen (vol.) .	0·65	0·89	1·11	0·69	0·88	1·38	0·88	1·03	0·91	0·98	1·05	0·78	0·74

Poumarède(1) has described an apparatus under the name *aërophore*, for the purpose of determining the quantity of exhaled water and carbonic acid. It consists of two tubes, which are provided with valves and unite in one mouth-piece; the air enters at one tube and passes out at the other, and is conducted over chloride of calcium and through a solution of potassa.

R. F. Marchand(2) has directed attention to the presence of ammonia in the exhaled air; L. Thompson(3) states it to be in the form of the bicarbonate, and that in man it amounts to about 0·19 grm. (3 grains, English) in twenty-four hours.

In reference to R. A. Smith's statements, in regard to an albuminous substance discharged with the exhaled air, *see* I. p. 298.

Digestion.—The question whether the gastric juice contains free hydrochloric acid, has been submitted by Lehmann(4) to experi-

(1) Compt. Rend. XXV, 254.
(2) J. Pr. Chem. XXXIII, 135.
(3) Phil. Mag. [3] XXX, 124.
(4) From the Ber. d. Gesellsch. d. Wissensch. in Leipzig III, 100, in J. Pr. Chem. XL, 137.

ment. He fed dogs, after they had fasted for from twelve to sixteen hours, on bones that had been as far as possible deprived of fat and skin, and killed them from ten to twenty-five minutes later. He found that their gastric juice, when evaporated *in vacuo*, did not evolve hydrochloric acid fumes, until concentrated to the consistence of syrup. In this gastric juice Lehmann found 1·808 per cent of solid residue, 0·125 hydrochloric acid, and 98·067 water. He also found that lactic acid, when still more concentrated, decomposes chloride of magnesium and chloride of calcium (but not the chlorides of potassium and sodium), and that this decomposition might have caused the evolution of hydrochloric acid. In proof of the presence of lactic acid, he mentions the preparation of a magnesia-salt from the gastric juice, the quantities of water and magnesia contained in which corresponded with those of lactate of magnesia ($MgO, C_6 H_5 O_5 + 3 HO$). The same salt was obtained from the gastric juice of dogs that had been fed, between twenty and forty-five minutes before their death, with flesh deprived of all its fat. This gastric juice, when evaporated *in vacuo*, yielded no fumes of hydrochloric acid, but left 5·602 per cent of solid residue. C. Schmidt(1) has suggested that the acid of the stomach may be a conjugate hydrochloric acid, analogous to ligno-sulphuric acid. Digestion.

According to Mulder's(2) views, albumin is at first only dissolved during digestion; while casein may perhaps also be oxidized. He arrives at this conclusion by comparing the composition of the albumin and casein dissolved in and reprecipitated from artificial gastric juice, with their composition in the usual condition.—We must confine ourselves to a mere mention of a treatise of Bouchardat and Sandras(3) on the digestion of alcoholic beverages.

Gastric Concretions.—Wetherill and Boyé(4) found that a concretion taken from the stomach of a horse, consisted of 32·40 per cent of phosphoric acid; 14·45 magnesia; 50·35 water; 0·71 ammonia; 0·45 inorganic substance, insoluble in dilute hydrochloric acid; 0·64 organic matter insoluble in the same solvent; and 1·00 hygroscopic moisture which escaped *in vacuo* over sulphuric acid.

Nutrition.—Sacc(5) has continued his former investigations into

(1) Ann. Ch. Pharm. LXI, 311.

(2) Scheik. Ond. IV, 396; Sill. Am. J. [2] IV, 402.

(3) Ann. Ch. Phys. [3] XXI, 448; J. Pr. Chem. XLIII, 175.

(4) From Proc. Amer. Phil. Soc. IV, 330 in Sill. Am. J. [2] IV, 274; Chem. Gaz. 1847, 277.

(5) Ann. Ch. Pharm. LII, 77.

Nutrition.

the nutrition of fowls(1); his communications being almost entirely numerical, admit of no abstract. We only cite the observation, that the weight of the animal is found to decrease as soon as the weight of the barley consumed in the day amounts to less than 5 per cent of the weight of the animal.

Kuhlmann(2) has communicated experiments which are intended to elucidate the influence of ammonia upon the nutrition of animals. A pig, with whose food a solution of 100 grms. of carbonate of ammonia was every day mixed, exhibited at the end of two months no difference in habit or weight, as compared to another whose food had no addition. The urine of the first pig generally showed an acid reaction, and appeared to contain more urea than that of the second.

On the subject of the nutrition of animals, see also the section on food, in our Report on Technical Chemistry.

Formation of Fat.—Payen(3) has reported observations to the effect that a larger proportion of fat in the food accelerates the fattening of graminivorous animals. Jacquelain(4) has communicated critical remarks on the experiments of Persoz(5), in regard to the formation of fat in the animal body. On the subject of the transformation of casein into fat, *see* II. p. 133.

Blood in the Normal Condition.—Béclard(6) has communicated investigations on the blood, from which he concludes: 1. That the blood passing from the spleen by the splenic vein contains a much smaller number of blood-corpuscles, not only than the arterial, but also than venous blood generally; 2. that the quantity of albumin contained in the blood of the splenic vein increases, whereas the quantity of the corpuscles diminishes; 3. that the arterial blood has the same composition at different points of the circulation, whereas that of the venous blood varies. The examination of the blood taken from one dog, yielded:

	Jugular vein.	Mammary artery.	Splenic vein.	Portal vein.
Water	778·9	750·6	746·3	702·3
Albumin	79·4	89·5	124·8	70·6
Corpuscles and fibrin	141·7	159·9	128·9	227·1

(1) Compt. Rend. XXVI, 124; J. Pr. Chem. XLV, 252.
(2) Compt. Rend. XXIV, 263.
(3) Compt. Rend. XXIV, 1065; J. Pr. Chem. XLII, 22.
(4) Ann. Ch. Phys. [3] XXI, 470.
(5) Instit. 1844, 422; Berzelius' Jahresber. XXV, 887.
(6) Ann. Ch. Phys. [3] XXI, 506; J. Pr. Chem. XLIII, 183.

Blood in the normal condition.

Owen Rees(1) has attempted to prove that the transition of venous into arterial blood, depends upon the oxidation of the phosphorus contained in the fat of the blood. He states that in the venous blood are corpuscles containing phosphoretted fat, and serum free from alkaline phosphates. The arterial blood, on the other hand, is stated to contain corpuscles free from phosphoretted fat, while the serum contains a large amount of alkaline phosphates. Respiration, according to this theory, consists of combustion of the phosphorus-fat of the corpuscles.

According to Bonnet(2), the addition of a solution of sugar to the blood, causes the corpuscles to separate unaltered, so that they can be easily separated from the fibrin in solution and from the serum. According to the effect upon the fibrin and the corpuscles, Bonnet distinguishes four classes of substances; such as neither alter the structure of the corpuscles nor the plasticity of the fibrin (serum and sugar-solution); such as dissolve the corpuscles and then prevent the coagulation of the fibrin (alkalies, weak acids, salts of ammonia); such as dissolve the corpuscles and leave the fibrin coagulable (water); and such as preserve the corpuscles and dissolve the fibrin (chloride of sodium, iodide of potassium, nitrate of potassa).

Poggiale(3) states that the addition of sulphate of soda effects the separation of the corpuscles from the blood of mammals, but not of birds, with which it forms a viscid fluid; and that a solution of sugar is applicable for the separation of the corpuscles in the blood of birds.

Roucher and Coulier(4) have examined the effect produced by soluble matters on the blood; the conclusions they arrive at are, that substances which are soluble in blood, and especially salts, operate upon the corpuscles by liberating the oxygen absorbed in the fluid, and causing it to unite with the corpuscles; and that the corpuscles are not dissolved in consequence of an absence of the influence of oxygen, but by their adhering to one another, which may be obviated by the addition of such substances as sugar, causing them to remain better suspended.

Casanti(5) has tried to distinguish the dried blood of man and various animals, by the different appearances produced in their mode of cohering, &c., on addition of phosphoric acid to the dried residue.

(1) Phil. Mag. [3] XXXIII, 28; J. Pr. Chem. XLVI, 129.

(2) Ann. Ch. Phys. [3] XXI, 189; J. Chim. Méd. [3] III, 631; J. Pr. Chem. XLII, 413.

(3) Compt. Rend. XXV, 110; J. Pr. Chem. XLIII, 292.

(4) Ann. Ch. Phys. [3] XXIII, 377.

(5) J. Chim. Méd. [3] IV, 673.

Blood in the normal condition.

Poggiale(1) has investigated the composition of the blood of new-born animals. In man he found the same amount of solid matter in the blood of the placenta as in that of the fœtus; and the composition of the former:

Water	744·2	Albumin	69·3
Corpuscles	172·2	Fatty matters	2·1
Fibrin	1·9	Extractive matters and salts	10·3

Of the latter:

Chloride of sodium	5·1	Sulphate of soda	0·5
Chloride of potassium	0·3	Phosphate of lime	0·4
Chloride of calcium	0·1	Sesquioxide of iron	2·0
Phosphate of soda	0·1	Carbonate and sulphate of lime	0·2
Carbonate of potassa	0·2	Loss	0·3
Carbonate of soda	0·2		

He infers that the blood of the new-born animal is rich in corpuscles and poor in fibrin, the amount of albumin and fatty matters almost as great, the amount of sesquioxide of iron more considerable than in the blood of the adult. He found the amount of solid matter in 1000 parts of blood to be in the:

Dog	aged 1 hour	231·5	Cat	aged 48 hours	155·9	Pigeon	aged 3 hours	179·8
„	„ 24 hours	228·3	„	8 days old	167·3	„	„ 24 „	180·4
„	„ 48 „	324·5	Rabbit	aged 3 hours	155·9	„	„ 70 „	189·9
Cat	„ 2 „	134·8	„	„ 24 „	162·9			
„	„ 6 „	136·2	„	„ 48 „	166·1			

The following was the composition of the blood:

	Age.	Water.	Corpuscles.	Albumin.	Fibrin.	Extractive matter and Salts.
Cat	3 hours.	864·3	82·9	40·2	1·7	9·3
„	24 „	862·5	84·2	42·3	1·7	9·3
Rabbit	3 „	842·2	90·2	56·9	2·2	8·6
„	24 „	839·6	91·3	58·1	2·2	8·7
Pigeon	3 „	822·3	130·1	35·9	3·1	8·6
„	24 „	816·3	134·2	37·8	3·4	8·3
Dog	1 „	768·5	165·1	56·7	1·7	8·0
„	24 „	771·7	163·3	55·3	1·7	8·1
„	48 „	775·5	158·5	56·2	2·0	7·8

Poggiale(2) has, moreover, examined the blood of man (both at the time that the usual diet was taken, and whilst 10 grms. of chloride of sodium were consumed daily; the latter analysis is marked *) and of several animals, and has been led to the following results:

(1) Compt. Rend. XXV, 198; J. Pr. Chem. XLIII, 295.

(2) Compt. Rend. XXV, 110; J. Pharm. [3] XIII, 150; J. Pr. Chem. XLIII, 292. The analyses of the human blood have been published also by Plouviez, at whose suggestion they were performed, Compt. Rend. XXV, 113; J. Pharm. [3] XII, 206.

Blood in the normal condition.

	Man.	Man*.	Ox.	Cow.	Calf.	Sheep.	Rabbit.	Dog.	Cat.	Fowl.	Pigeon.
Water . . .	779·9	767·6	796·1	788·2	835·6	798·0	831·0	798·0	812·0	785·0	795·0
Blood-corpuscles .	130·1	143·0	123·2	126·2	92·5	102·0	91·5	126·0	109·2	150·3	143·2
Albumin . . .	77·4	74·0	65·5	67·2	55·3	85·0	63·8	63·0	64·1	47·2	48·1
Fibrin . . .	2·1	2·3	5·4	6·3	4·1	3·2	3·2	2·2	2·2	5·1	5·1
Fatty matters . .	1·1	1·3	2·2	2·2	1·3	1·8	1·6	2·3	2·1	2·3	1·7
Extractive matters & salts . . .	9·3	11·8	8·7	10·0	11·2	10·0	8·9	8·5	10·3	9·1	8·9
The latter contain:											
Chloride of potassium and sodium . .	4·7	6·4	4·7	4·8	6·1	5·7	4·6	4·4	5·6	5·0	5·4
Chloride of calcium .	—	—	0·2	0·2	0·3	0·2	0·3	0·2	0·3	0·1	0·2
Phosphate of soda .	1·4	1·7	0·8	0·8	1·1	1·0	0·8	0·8	0·9	0·8	0·8
Sulphate of soda .	0·4	0·4	0·6	0·3	0·8	0·6	0·6	0·5	0·7	0·4	0·3
Carbonate of potassa and soda . .	0·5	0·6	0·4	0·9	0·4	0·3	0·4	0·3	0·5	0·4	0·2
Phosphate of lime .	0·7	0·7	0·5	1·0	0·8	0·7	0·5	0·5	0·7	1·2	1·1
Sesquioxide of iron .	1·3	1·5	1·3	1·4	1·1	1·1	1·0	1·5	1·2	0·8	0·6
Carbonate and sulphate of lime .	0·3	0·4	0·2	0·4	0·3	0·2	0·3	0·1	0·2	0·3	0·2
Loss . . .	0·1	0·2	0·2	0·2	0·3	0·2	0·4	0·1	0·2	0·2	0·2

The investigations of Strahl and Lieberkühn(1) on uric acid in blood may be passed over in silence. They are characterized by an ignorance of the substances to be examined, an ignorance of the reactions by which they are to be recognized, a petty entering into unimportant details, and a remarkable slurring over of points which are most essential in such investigations—faults unfortunately but too often met with in the cultivators of biochemistry of the present day. In proof of the above strictures it may be mentioned, that the authors when treating of murexide as demonstrating the presence of uric acid, consider the formation of murexide to consist merely in the red colour produced by the treatment of a uric acid fluid with nitric acid; nothing is said of the addition of ammonia to the residue of the fluid evaporated after the treatment with nitric acid, although the treatise is rich enough in similar points of detail.

Boussingault(2) has examined the influence of food on the amount of fat contained in the blood. He agrees with Sandras and Bouchardat, that no definite influence of the kind is demonstrable. Boussingault found, in examining the blood of birds which had consumed various kinds of food (*vide infra*), or had not been fed for thirty-six hours, the following amounts of fat in 1 part by weight:

(1) Harnsäure im Blut und einige neue constante Bestandtheile des Urins, Berlin, 1848.

(2) Ann. Ch. Phys. [3] XXIV, 46.

Blood in the normal condition.

Pigeons	0·0021	(starch.)	
Ditto	0·0046	„	
Ducks	0·0042	„	
Ditto	0·0044	(albumin and gelatin.)	
Ditto	0·0049	(nuts.)	
Ditto	0·0034	(nothing.)	
Pigeons of 3 weeks	0·0056	(albumin.)	
	0·0043	(nothing.)	
Pigeons of 1 month	0·0055	(albumin.)	
	0·0065	(lard.)	
	0·0036	(nothing.)	
	0·0070	(nothing.)	

Blood in Abnormal Conditions.—Poggiale and Marchal(1) have analysed the arterial (A) and venous (B) blood of a patient suffering from inflammation of the brain, following erysipelas; Grassi(2) has examined the blood (C) of a person labouring under hydrocele, which proved to contain more than the normal amount of albumin and salts. Chatin and Bouvier(3) analysed the blood (D) of a person suffering from scurvy, in which the fibrin was found increased, the amount of corpuscles and albumin diminished; Favre(4) made a similar analysis (E), and found an increase in the water, a considerable diminution of the corpuscles, and an increase of the fibrin. Becquerel and Rodier(5) have stated, as general results, obtained by repeated analyses of such blood, that it is of less density, contains more water, fewer corpuscles, and as much, or more fibrin than normal blood. Léonard and Foley(6) have communicated a series of analyses on the composition of the blood in the endemic diseases of Algiers, and Michéa(7) has analysed the blood of insane persons.

	A.	B.	C.	D.	E.
Solid matters generally	177·5	181·6	269·7	—	—
Soluble, non-coagulable substances	—	—	—	16·3	—
Fibrin	6·2	6·1	2·9	4·0	4·4
Albumin	66·0	61·3	—	62·3	—
Corpuscles	97·5	106·0	116·7	86·3	44·4
Fatty matters	1·1	1·2	—	—	—
Chloride of sodium	3·1	3·3	—	—	—
Soluble salts	2·1	2·2	—	—	—
Phosphate of lime	0·8	0·8	—	—	—
Sesquioxide of iron	0·6	0·6	—	—	—
Albumin and salts	—	—	149·9	—	—
Solid matters in serum	—	—	—	—	76·6
Water	822·5	818·4	730·3	831·1	874·6
Loss	0·1	0·9	0·2		—

(1) J. Chim. Méd. [3] IV, 235; Compt. Rend. XXVI, 143; J. Pharm. [3] XIV, 363.
(2) J. Pharm. [3] XIV, 364.
(3) J. Chim. Méd. [3] IV, 141.
(4) Compt. Rend. XXIV, 1136.
(5) Compt. Rend. XXIV, 1090; J. Pr. Chem. XLI, 350.
(6) J. Chim. Méd. [3] III, 365.
(7) Gaz. Méd. de Paris, 9, 10 and 11, 1848; Schmidt's Jahrb. der ges. Med. LXI, 145.

Blood in abnormal conditions.

Lassaigne(1) has analysed the blood of dogs before and after etherization; air saturated at 15° with ether-vapour contains, according to this author, about 35·4 vol. of the latter to 13·5 oxygen, and 51·1 nitrogen. He estimates the quantity of ether contained in venous blood, after etherization, at 0·081 per cent.

	In 100 parts.		In 1000 parts.			
	Crassamentum.	Serum.	Water.	Fibrin.	Corpuscles.	Albumin & alk. salts.
Arterial blood, before	57·7	42·3	797·0	3·8	144·7	54·5
„ „ after	46·4	53·6	809·2	3·9	131·7	55·3
Venous blood before	53·5	46·5	798·7	3·6	145·3	52·4
„ „ after	48·3	51·7	813·3	3·4	122·1	61·2
„ „ before	65·5	34·5	723·6	2·4	183·1	90·9
„ „ after	59·7	40·3	778·9	1·7	147·4	72·0

Blood of Lower Animals.—Harless(2) has communicated observations on the blood of the Ascidia and of the Cephalopoda generally. The blood of these animals is colourless in the vessels, and assumes a deep-blue colour on exposure to the air, by the influence of the carbonic acid contained in the latter. Oxygen, again, almost entirely removes the colour. Bibra found in the blood of *Eledone* 7·33 solid parts to 92·67 water; 100 dry blood yielded 35·88 ash; 100 ash contained 73·1 chloride of sodium, 2·0 sulphate of soda, a doubtful trace of phosphate of soda, and 24·9 phosphate of lime and copper. Iron was not found, nor was it traced in the liver. There were 1·12 per cent of copper in the ash of the latter. Copper has also been found in *Cancer pagurus*, *Acanthias zeus*, and *Conger vulgaris*; its amount was in an inverse ratio to the quantity of iron present. The blood of *Helix pomatia* also contains much copper; the part of the ash which was insoluble in water contained 2·57 per cent. This blood likewise became blue (in winter) on exposure to the air, but the blue colour was destroyed by carbonic acid, and restored by oxygen. The colouring matter was precipitated by alum, redissolved by an excess, and reprecipitated by ammonia. The combination of colouring matter and alumina yielded 29·53 per cent of a green ash rich in copper.

Amount of Carbonic Acid or Carbonated Alkali in the Blood.—Lehmann(3), to establish the view that blood contains a carbonated

(1) J. Chim. Méd. [3] III, 182, 249.

(2) Müller's Archiv. 1847, Nr. 2, 148; Edinburgh Monthly Journal, May, 1848; Chem. Gaz. 1848, 214.

(3) Ber. d. kgl. sächs. Gesellsch. d. Wissench. zu Leipzig. III, 96; J. Pr. Chem. XL, 133.

Amount of carbonic acid or carbonated alkali in the blood.

alkali, has communicated results of experiments, in which the free carbonic acid was first expelled by hydrogen introduced into the blood, the combined carbonic acid being subsequently removed in a rarified space by acetic acid. According to his determinations, 1000 grms. of fresh ox-blood contains, on an average, 0·132 grms. (70 cub. cent.) of free, and 0·676 (360 cub. cent.) of combined carbonic acid.—He mixed blood with an equal quantity of water, coagulated the albuminous constituents by heat, and evaporated the fluid after separation from the coagulum. The residue was incinerated at the lowest possible temperature; in 100 parts of ash there were found from 4·1 to 4·4 of sulphate of soda; 3·7 phosphate of soda (3 NaO, PO_5), from 15·8 to 18·1 carbonate of soda, and from 74·0 to 75·0 of alkaline chlorides.(1)

Liebig(2) has made the following remarks on the property of the serum of the blood to absorb more carbonic acid than does an equal volume of water, and on the presence of carbonate of soda in the blood; it may be observed that many have supposed this property to depend on the conversion of the latter into the bicarbonate. 1 vol. of water absorbs 1 vol., 1 vol. of serum 2 vols. of carbonic acid; if the absorption of an extra volume depended upon the formation of bicarbonate of soda, 1 vol. of serum should originally contain 1 vol. of carbonic acid in the shape of neutral carbonate of soda, and on mixing 1 vol. of serum, saturated with carbonic acid, with acids, 2 vols. of carbonic acid ought to be evolved, provided that the third volume remained absorbed in the acid fluid. In reality, however, we find, that in this case much less carbonic acid is evolved, even less than ought to be evolved under the supposition that the acid added holds an equal volume of carbonic acid in solution. Serum that has been strongly concentrated by evaporation evolves no measurable trace of carbonic acid gas on the addition of acids. The greater capacity for the absorption of carbonic acid, possessed by serum, as well as its alkaline character, depends upon the presence of phosphate of soda which it contains(3). A solution of 1 part of dry phosphate of soda (2 NaO, HO, PO_5) in 100 parts of water, absorbs likewise a double volume of carbonic acid. By shaking up with

(1) These statements do not apply to blood in general, but only to the blood of bullocks; they prove indubitably the presence of carbonate of soda in the ash of blood, but whether an alkaline carbonate is dissolved in the blood as such, remains still to be ascertained.

(2) Loc. cit. II. p. 161.

(3) Or upon a salt with alkaline base and alkaline reaction, which evolves the absorbed carbonic acid again on the application of heat.

Amonnt of carbonic acid or carbonated alkali in the blood.

air, or by diminishing the atmospheric pressure, two-thirds of the carbonic acid taken up are evolved at the ordinary temperature; the entire amount of carbonic acid gas is given off during simple evaporation in the atmosphere. When the blood absorbs carbonic acid, the soda of the former is appropriated partly by the carbonic acid and partly by the phosphoric acid, but the phosphoric acid which has been expelled remains and tries to reunite itself with all the soda, consequently the phenomena are different from what they would be if the blood really contained carbonate of soda as such.

Ash of Blood.—Henneberg(1) has analysed the ash of the blood of fowls (A), and of a mixture of the blood of fowls and turkeys (B, the former predominating). The ash was white and did not effervesce with acids, the aqueous extract yielded a pure white precipitate with nitrate of silver. The results were, after subtraction of the charcoal:

	A.	B.		A.	B.
Phosphoric acid, combined with an alkali	19·63	20·24	Chloride of potassium	29·14	36·81
Phosphoric acid, combined with earths and metallic oxides	6·99	8·49	Chloride of sodium	16·87	3·31
Sulphuric acid	1·19	0·97	Soda	21·04	24·02
			Sesquioxide of iron	3·89	4·77
			Lime	1·03	0·93
			Magnesia	0·22	0·46

Enderlin(2) has examined the ash of the blood of various animals, and communicates the following results. (The numbers subjoined in brackets to the names of the animals indicate the amount of ash obtained from 100 parts of blood.)

	Goose. [1·22]	Goose 1) [1·28]	Young cock. [1·23]	Young cock. [1·13]	Young cock. 2)	Young cock. 3)	Young cock. 4)	Young cock 5)
$2\,Fe_2O_3$, $3\,PO_5$	9·61	11·07	8·15	7·95	8·45	8·70	7·5	7·6
$2\,CaO$, PO_5	9·34	12·54	9·63	13·26	14·79	14·50	15·0	15·2
$2\,MgO$, PO_5	6·04	8·47						
$2\,KO$, PO_5	26·24	18·57	36·38	18·36	52·34	50·48	25·0	24·4
$2\,NaO$, PO_5	6·18	20·68	3·17	7·19	—	—	—	—
KO, SO_3	2·34	0·65	—	3·30	—	—	—	—
$3\,NaO$, PO_5	—	—	—	—	—	—	—	—
$NaCl$	39·84	27·20	40·13	46·56	20·89	23·57	37·9	38·4
$3\,NaO$, $2\,SiO_3$	—	—	2·98	—	—	—	—	—
$3\,KO$, $2\,SiO_3$	—	—	—	—	3·53	2·75	14·6	14·4

1) This goose had been fed for a considerable period with maize; the blood was chocolate-coloured, and did not separate into coagulum and serum.

2) Fed for some time on wheat. 3) The same.

4) Fed on barley. 5) As the last.

(1) Ann. Ch. Pharm. XXI, 255; corrected, LXVI, 112.

(2) Ann. Ch. Pharm. LXVII, 304.

Amount of carbonic acid or carbonated alkali in the blood.

	Pigeon. [1·20]	Pigeon. [1·29]	Pigeon. [1·55]	Duck. [1·05]	Frog. [0·84]	Frog.	Perch. [1·11]
2 Fe_2O_3, 3 PO_5	9·4	10·0	9·8	10·0	9·61	10·5	9·5
2 CaO, PO_5 / 2 MgO, PO_5	13·2	12·1	13·4	17·3	13·5	7·9	9·5
2 KO, PO_5	20·4	39·5	34·9	28·0	—	—	36·0
2 NaO, PO_5	26·4	37·9	31·3	17·1	—	—	—
KO, SO_3	1·9	—	—	4·0	1·6	1·7	—
3 NaO, PO_5	—	—	—	—	38·5	40·4	—
Na Cl	28·6	—	7·5	21·6	31·8	39·3	43·4

The ash of birds' and fishes' blood was white, that of frogs like that of omnivorous animals reddish-yellow. The ashes of birds' blood were soluble in hydrochloric acid without evolution of gas. Enderlin has also given some analytical data in reference to the ash of the crassamentum of cock's and duck's blood, and of the serum of the latter.

Metals in the Animal Organism and especially in the Blood.— The question whether besides iron (and manganese) there are other heavy metals, such as copper, lead, &c., in the healthy animal body, has been repeatedly discussed. In 1832, Sarzeau stated that flesh contained copper; in 1838, Devergie and Hervy asserted that they had found varying quantities of copper and lead in the ash of the internal organs of different individuals, who had died a natural death. Danger and Flandin subsequently denied the presence of copper in the healthy human body, Barse asserted its presence as well as that of lead. The following treatises belong to the period which this report more especially embraces. Legrip(1) considers the copper and lead which he found in the human liver and spleen as a normal constituent (in 3300 parts. of ash of the human liver and he found 2·7 of lead, and 4·5 of copper; in 8700 parts of ash of the stomach, rectum, bones, marrow, and tendons of a cow he found 3·2 of lead and 8·2 of copper). Orfila(2) contends that the liver always contains copper, and probably also the other organs. Chevallier(3) states that the organs in their normal state, generally contain copper and lead but not invariably. Deschamps(4) arrives at the conclusion that all sedimentary formations contain copper

(1) J. Chim. Méd. [3] III, 251.
(2) J. Chim. Méd. [3] III, 370.
(3) Ibid. [3] III, 375.
(4) J. Pharm. [3] XIII, 88; Compt. Rend. XXVI, 102.

in addition to iron, that plants take it up, and that it is contained in man and animals in the normal state.(1)

Metals in the animal organism and especially in the blood.

Millon(2) makes the following remarks, especially in reference to the metallic contents of the blood. If the blood be received from the vein in a vessel containing about treble the quantity of water, and the fluid introduced into a flask filled with chlorine, it becomes brown, and soon a grey mass is formed, out of which the fluid portion may be easily expressed and washed; almost all the organic constituents are to be found in the coagulated portion; the salts of the blood are in the fluid part. If the latter be evaporated to dryness and calcined, he states that 100 parts of the insoluble portion of this residue contains from 1 to 3 of silicic acid, 1 to 5 of lead, 0·5 to 2·5 of copper, and 10 to 24 of manganese; and that the copper and lead are constituents of the corpuscles, as 1000 grms. of crassamentum (human) yielded 0·083 of these metals, whilst 1000 parts of serum only yielded 0·003.—Melsens(3) was unable, by the most careful analysis, to discover copper or lead in the blood of the horse, the dog, or of man.—Millon(4) still contended that he had actually found these metals in the blood, but admitted that accidental circumstances might have given rise to their presence; he subsequently attributed(5) the occurrence to his having examined the blood of soldiers, whose cooking utensils consisted of metal.—Deschamps(6) equally affirms that he found copper in the ash of human blood; and Harlefs (*see* II. p. 157) in the blood of the inferior animals.

Examination of the Juice of Flesh.—Liebig(7) has published researches on the constituents of the juice of flesh; he premises observations on the direction which, during the last years, numerous investigations in animal chemistry have assumed; and adds an historical exposition of the statements in regard to the various con-

(1) The result formerly arrived at by Millon and Laveran, that in animals which have taken tartar emetic, the antimony is retained for a long time, has been confirmed more recently by Millon (Ann. Ch. Phys. [3] XIX, 138.)

(2) Compt. Rend. XXVI, 41; Ann. Ch. Phys. [3] XXIII, 372; Instit. 1848, 10; J. Pharm. [3] XIII, 86; J. Pr. Chem. XLIII, 388.

(3) Ann. Ch. Phys. [3] XXIII, 358; J. Chim Méd. [3] IV, 486; J. Pr. Chem. XLV, 440.

(4) Ann. Ch. Phys. [3] XXIII, 508; J. Pr. Chem. XLV, 452.

(5) Ann. Ch. Phys. [3] XXIV, 255.

(6) J. Pharm. [3] XIV, 410; Compt. Rend. XXVII, 389; J. Chim. Méd. [3] V, 20; J. Pr. Chem. XLVI, 115.

(7) Ann. Ch. Pharm. LXII, 257; Ann. Ch. Phys. [3] XXIII, 129; J. Pr. Chem. XLIII, 281; J. Pharm. [3] XII, 227, 386; Compt. Rend. XXIV, 69, 195 (in part.)

Examination of the juice of flesh.

stituents of the flesh-juice, and more especially of lactic acid and creatin.

In order to obtain the soluble portions of muscle(1), f. i. of 10 lb. of finely chopped meat, free from fat, Liebig advises that 5 lbs. be carefully kneaded with 5 lbs. of water, and well expressed in a bag of coarse linen, and that the residue be treated a second time with 5 lbs. of water. The fluid obtained by the latter procedure is used to treat the second 5 lbs. of flesh for the first time; the latter are treated a second time with the fluid obtained after a third exhaustion of the first portion of flesh, and then soaked in pure water, and squeezed. The fluids are mixed, strained through cloth, and heated in a glass flask with water, until the latter boils, when the albumin and the colouring matter coagulate successively; this temperature is maintained until the fluid becomes colourless, and both substances are entirely separated by coagulation. For many kinds of flesh it is necessary, in order to secure the entire removal of the colouring matter, to separate the fluid from the clot after the coagulation of the albumin, and to heat it to ebullition in another vessel. This fluid, as well as the fluid contained in the coagulum, is strained through cloth; if prepared from flesh containing much blood, as beef, venison, hare, and fox, it is reddish; whereas that from veal, fowls, and fish, is almost colourless. The fluid prepared in this manner from horse-flesh and fish is always turbid, that from the other varieties of flesh mentioned is transparent. They all taste nearly alike; the fluid obtained from the flesh of the marten, has a distinct odour of musk. The fluid invariably possesses an acid reaction. When concentrated over an open fire, even though ebullition be avoided, it assumes a brown colour, and at last a dark-brown syrup remains, having the odour of roast meat, in which, after standing a long time, traces of creatin-crystals become visible. The brown colour depends partly upon the formation of a deposit at the bottom of the vessel, which assumes a higher temperature; but also occurs inevitably even when the evaporation is effected on the water-bath. The chief cause of this change is, together with the tempe-

(1) The flesh of fish must be treated differently, because when finely chopped with water, it swells up into a slimy mass, which clogs the cloth. It is to be mixed with a double volume of water, placed upon a funnel, and the flesh-juices displaced by the gradual addition of small quantities of water. The extract is colourless, slightly opalescent, acid, and tastes and smells strongly of fishes. When heated, a soft coagulum is deposited, and the fluid, after the addition of baryta-water, evaporation, and cooling, yields a colourless jelly, in which, after twenty-four hours, distinct and regular crystals of creatin are deposited. (*See* Gregory's statement, II. p. 164).

rature, the free acid contained in the fluid, which for that reason must be removed previous to evaporation. For that purpose a concentrated solution of caustic baryta is to be added to the fluid, so long as a white precipitate forms, which occasionally takes place even after the fluid has become neutral, or alkaline. The precipitate contains all the phosphoric acid of the flesh-juice, in the shape of phosphate of baryta and phosphate of magnesia, but no phosphate of magnesia-ammonia (once only a distinct evolution of ammonia was perceived, after the addition of the baryta-water). The amount of sulphate of baryta is so trifling, that it may be attributed to the juice of blood which had remained. The fluid that is separated from this precipitate is evaporated in shallow porcelain dishes, ebullition being avoided. If the upper edge of the vessel becomes hotter than the fluid, the latter dries up, so as to form a dark-brown ring, which is redissolved on the addition of more fluid, without sensibly discolouring the latter; but on concentration the colour reappears. The fluid of the fowl's-flesh, treated with baryta-water, remains clear when evaporated; unless a coating of carbonate of baryta be formed at the surface, in consequence of an excess of the baryta added. When the fluid derived from beef is evaporated to the consistence of a thin syrup, a slimy coat forms on the surface, which swells up in water, but does not dissolve in it. In treating veal and horse-flesh, these coats form continuously if they are removed, as they should be. When the fluid has been reduced to about $\frac{1}{20}$ of its bulk, it is placed in a moderately warm place, and allowed to evaporate spontaneously, when the creatin is soon deposited in crystals on the walls of the vessel.

Examination of the juice of flesh.

Creatin is a constituent of the muscles of all the superior animals; Liebig found it in the flesh of the bullock, the sheep, the pig, calf, deer, hare, marten, fox, stag, fowl, and pike; Schlossberger(1) had obtained it from the flesh of an alligator. The flesh of the fowl and the marten contained the greatest quantity, that of the other animals less, fish the least. The flesh of a fox, which had been fed on meat for two hundred days, did not yield the tenth part of the creatin obtained from the same amount of flesh from a fox killed in the chase. Fat meat, containing the same amount of fibre as lean meat, yields less creatin than the latter. 100 lbs. of flesh from an old lean horse yielded nearly 36 grms. of creatin; one hundred and sixteen lean fowls (the meat of a fowl weighed, on an average, 203 grms.) about 72 grms.; 86 lbs. of beef 30 grms. The heart of

(1) Ann. Ch. Pharm. XLIX, 343.

Examination of the juice of flesh.

the ox contains it in large proportion(1). No creatin could be obtained from the cerebral, hepatic, and renal tissues. If cerebral matter be triturated with baryta-water, so as to form a thin milky fluid, then strained through a fine sieve and boiled, a coagulum is formed, which contains all the cerebral fat, and a clear, yellowish fluid; if the latter be freed from the excess of baryta, by a current of carbonic acid and heat, it contains two baryta-salts, which are soluble in water, and yield a white flocculent precipitate with acids, one of which is soluble in alcohol. As to the occurrence of creatin in the urine, and its formation from creatinine, *see* the chapter on urine.

The creatin-crystals that subside in the flesh-juice on cooling, are washed first with water, and then with spirits of wine; they are recrystallized from boiling water, if necessary, with the assistance of a little animal charcoal, when, on cooling, the creatin is separated in pure crystals. If the phosphoric acid had not been entirely removed from the fluid by baryta-water, the creatin-crystals obtained from the mother-liquor will have an admixture of phosphate of magnesia, of which a small portion again mixes with the creatin, when it recrystallizes. In order to separate this impurity, the hot filtered solution is boiled with a little hydrated protoxide of lead, filtered, and a trace of lead removed from the solution by a little animal charcoal. The crystals of creatin are colourless and transparent, they belong to the monoclinometric system, and bear a resemblance to those of sugar of lead(2). The crystals are $C_8 H_9 N_3 O_4 + 2\,HO$; at 100^0 they become opaque, and lose 2 HO. Creatin is easily soluble in boiling water; the boiling saturated solution solidifies, on cooling, into a mass of fine, shining needles; it crystallizes more slowly

(1) Gregory (Chem. Soc. Qu. J. I, 25; Ann. Ch. Pharm. LXIV, 100) observed that the flesh of the ray (*Raja batis*) and the cod-fish (*Gadus morrhua*), may be easily exhausted and expressed, and is in every way adapted for obtaining creatin. He obtained from 100 parts of flesh the following proportions of creatin:

Fowl.	Bullock's-heart.	Cod-fish.	Pigeon.	Ray.
2·9 to 3·21	1·38 to 1·42	0·94 to 1·7	0·83	0 to 0·61

Schlossberger (Ann. Ch. Pharm. LXVI, 80) obtained nearly 2 grms. of creatin from 6 lbs. of human muscle; during its preparation, the above-mentioned slimy coats (*see* p. 163) were constantly deposited; they presented an entirely amorphous condition under the microscope.

(2) Heintz (Pogg. Ann. LXXIII, 595) found by microcrystallometric measurements, that the angle between the clinodiagonal and the principal axis $= 70^0\,20'$ (by the reflecting goniometer $71^0\,5'$), $\infty P : \infty P$ in the orthodiagonal principal section $= 133^0\,2'$ to $133^0\,8'$ (by the reflecting goniometer $133^0\,10'$). Comp. the article on creatinine.

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from a dilute solution, in large, pretty crystals, often of from $\frac{1}{6}$ to $\frac{1}{4}$ of an inch in length, and $\frac{1}{12}$ of an inch in thickness; 1 part of creatin dissolves in 74·4 of water at 18^0, and in 9410 of cold alcohol (easier in dilute spirits of wine). The cold aqueous solution has a slightly bitter, rather astringent taste, and easily becomes mouldy if it contains a foreign organic substance. Creatin, even in large quantities, is incapable of neutralizing the acid reaction of the weakest acid; it dissolves when heated in baryta-water, and crystallizes without being changed; when boiled with solution of baryta it is decomposed, ammonia being evolved, and carbonate of baryta separated (comp. II. p. 167). In a warm concentrated solution of creatin the colour of peroxide of lead does not change even on boiling, and the creatin-crystals that are deposited on cooling, are free from protoxide of lead. A solution of permanganate of potassa, in which creatin is dissolved, does not lose its red colour until it has stood a long time in a warm place; there is no perceptible evolution of gas, and the fluid then no longer contains creatin. It yields white crystals on evaporation, and the potassa proves to be partially converted into carbonate.

If the creatin be dissolved in a mineral acid, and the solution evaporated at a moderate temperature, we obtain crystals, which are no longer unaltered creatin, but are easily soluble in alcohol, and hold a part of the acid in chemical combination. By the elimination of water in this reaction, the creatin is converted into a new organic base, *creatinine*, $C_8 H_7 N_3 O_2$. It may be obtained in an aqueous solution, if carbonate of baryta be added to a boiling aqueous solution of the sulphate of creatinine, until effervescence ceases, and the fluid exhibits an alkaline reaction. Another method consists in dissolving the hydrochlorate in from 24 to 30 parts of water, heating the solution in a porcelain vessel to ebullition, and adding small quantities of levigated, hydrated protoxide of lead; the fluid is thus gradually rendered neutral or slightly alkaline, and a treble quantity of the hydrated protoxide already consumed being superadded and ebullition being continued, it seems to coagulate into a thick light-yellow paste. The fluid is then filtered and the residue washed; in case of the filtrate containing a trace of lead suspended or in solution, this must be removed by treatment with a little animal charcoal. This method depends upon the conversion of the chloride of lead into a basic combination, which is insoluble in water. The creatinine crystallizes out of the aqueous solution after concentration in the water-bath, on cooling, in monoclinometric crystals, according to H. Kopp's determination, in the combination: $\infty P . 0P . \infty P \infty$; $0P : \infty P \infty = 69^0 24'$; $\infty P : \infty P$ in the ortho-

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diagonal principal section = 98° 20′(1). The crystals $C_8 H_7 N_3 O_2$ dissolve in 11·5 times their weight of water at 16°, in less hot water; in 102 parts by weight of alcohol at 16°, and easier in boiling alcohol. The aqueous solution blues reddened litmus-paper, and has a caustic taste when concentrated; a crystal of creatinine causes a brown spot on wet turmeric-paper. If a solution of creatinine be added to a moderately concentrated solution of nitrate of silver it causes a coagulation into a mass of fine white needles, easily soluble in hot water, and crystallizing unchanged out of it on cooling, they are a basic combination of creatinine with nitrate of silver. Solution of creatinine yields with a solution of protochloride of mercury at once a white curdy precipitate, which in a few minutes is converted into an aggregate of fine, transparent, colourless needles; with a neutral aqueous solution of protochloride of zinc a granular crystalline precipitate is at once produced(2). Creatinine expels the ammonia from the ammonia-salts, and forms beautifully blue crystallizable double salts with salts of protoxide of copper.—Hydrochlorate of creatinine is formed from crystallized creatin by passing, at 100°, a current of dry hydrochloric acid gas over the latter in a Liebig's desiccating apparatus; the weight of the product is at last almost identical with that of the crystallized creatin employed, as H Cl is substituted for the 4 HO that are separated, both having nearly the same weight. This salt is also formed when creatin is treated with concentrated hydrochloric acid, the solution being evaporated, and the dry mass heated in the water-bath until all the free hydrochloric acid is removed. It is pretty soluble in boiling alcohol, out of which it crystallizes in short transparent, colourless prisms, which are with difficulty soluble in water. On evaporation, it is obtained in broad transparent plates of very acid reaction. Its composition is $C_8 H_7 N_3 O_2$, HCl. A boiling saturated alcoholic solution of this salt, to which ammonia is added until the acid reaction has disappeared, yields on cooling small, transparent, granular crystals of creatinine. Bichloride of platinum causes no precipitate in a dilute solution of hydrochlorate of creatinine, but on

(1) Heintz also (Loc. cit. II. p. 164) found ∞ P : ∞ P in the orthodiagonal principal section = 98° 20′, 0 P : ∞ P = 102° 36′, and thence 0 P : ∞ P ∞ = 70° 30′; the latter angle direct = 69° 57′. He points out that creatin and creatinine possess almost the same angle of inclination between the principal axis and the clinodiagonal, and that for the orthodiagonal of the same length, the clinodiagonal of the former is to that of the latter nearly as 2 : 1.

(2) Heintz's experiments prove (Pogg. Ann. LXX, 475) that this precipitate, which he took for a creatin-compound (see chap. on urine), when dried at 120°, only yields traces of hygroscopic water, and is $C_8 H_7 N_3 O_2$, Zn Cl.

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evaporation at a gentle heat, dark-yellow or pink, transparent, rather large crystals form, which are easily soluble in water, with more difficulty in alcohol; the same compound is produced when a creatinine-solution is evaporated to which a small portion of hydrochloric acid and bichloride of platinum have been added; its composition is $C_8\ H_7\ N_3\ O_2$, HCl, Pt Cl_2.—When 1 part of creatinine is evaporated with an equal weight of a mixture, consisting of 27 parts of concentrated sulphuric acid with 73 of water, or when a boiling saturated solution of creatinine, to which dilute sulphuric acid has been added until the reaction is strongly acid, is evaporated, sulphate of creatinine is obtained as a white salt-residue; this is easily soluble in warm alcohol, the solution on cooling becomes opaque, and deposits transparent, concentric, square-prismatic plates, $C_8\ H_7\ N_3\ O_2$, HO, SO_3, which remain clear and transparent at 100^0.

In reference to the occurrence of creatinine in the juice of flesh, *see* II. p. 171; on the subject of creatinine in urine, and of the conversion of creatinine into creatin, *see* the section on urine.

If, to a boiling concentrated solution of creatin, ten times the amount of hydrate of baryta be added, the solution at first remains clear, but on continuing the ebullition, a copious evolution of ammonia is effected, and a white crystalline powder is deposited on the sides of the vessel. If more hydrate of baryta be added, the water renewed as it evaporates, and the boiling continued until ammonia is no longer evolved, a clear colourless fluid is obtained on filtering, which contains free caustic baryta and a new organic base, *sarcosine*. A current of carbonic acid is passed through the fluid, when, on boiling it, the baryta is deposited. The fluid, when evaporated to a syrup solidifies, when left at rest, into an aggregate of broad, colourless, transparent plates. The caustic baryta should be perfectly pure, because every impurity would remain with the sarcosine. In order to obtain pure sarcosine, it is advisable to combine it with sulphuric acid, and to separate it again. For this purpose dilute sulphuric acid is to be added to the sarcosine obtained by evaporation of the filtrate, until the reaction becomes powerfully acid; the fluid is evaporated on a water-bath, alcohol added to the syrupy residue, and the mixture stirred with a glass rod. The syrupy sulphate solidifies into a white crystalline powder, which must be washed with cold alcohol, dissolved in water and warmed with pure carbonate of baryta, until effervescence no longer ensues, and the acid reaction of the solution has disappeared. The filtrate is evaporated to a syrup on the water-bath, and when left to stand at rest for from twenty-four to thirty-six hours, the sarcosine crystallizes out. The crystals belong to the rhombic system; they exhibit ∞ P, $\bar{P}\infty$,

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rarely and slightly P and 0 P (∞ P : ∞ P = 77^0); they are colourless, transparent, very soluble in water, difficultly soluble in alcohol, and insoluble in ether. When dried at 100^0, they maintain their appearance; at a higher temperature they melt, and are volatilized without leaving a residue. If a few crystals are heated for a short time to 100^0, between two watch-glasses, they sublime so as to form a net-work of crystals. The composition of sarcosine is $C_6 H_7 N O_4$; it contains the same elements, and in the same proportion, as Pelouze's lactamide and Dumas' urethane; it is, however, sufficiently distinguished from both by its insolubility in ether and alcohol. It is formed from the crystallized creatin ($C_8 H_{11} N_3 O_6$) by elimination of the elements of urea ($C_2 H_4 N_2 O_2$), which is found to be contained in the fluid before the decomposition of the creatin by baryta is terminated. The carbonic acid and the ammonia evolved during this decomposition, are secondary products originating in the decomposition of the urea(1). The aqueous solution of sarcosine presents no reaction on vegetal colours; it has a sweetish, acrid, slightly metallic taste; it causes no alteration in a dilute solution of nitrate of silver or protochloride of mercury. But if a crystal of sarcosine be introduced into a cold-saturated solution of protochloride of mercury, it immediately dissolves, and many fine, transparent needles of a double compound are soon formed, into which, if sufficient sarcosine be present, the entire fluid is converted. A solution of acetate of copper assumes, on the addition of sarcosine, a deep-blue colour, and on slight evaporation, plates of a double salt, of the same colour, are obtained. If the sarcosine be evaporated with hydrochloric acid, hydrochlorate of sarcosine is deposited in the form of a white salt, which crystallizes from hot alcohol in the shape of transparent grains and needles. If an excess of bichloride of platinum be added to a solution of hydrochlorate of sarcosine, no precipitate results; if this solution be allowed to evaporate spontaneously, large, honey-coloured octohedrons (the excess of bichloride of platinum may be removed from the crystals by a mixture of alcohol

(1) Sarcosine and urea are not the only products of the decomposition of creatin by baryta; if water be added to the alcohol from which the sulphate of sarcosine has crystallized, the fluid neutralized with carbonate of baryta, and evaporated to a thin syrup, a deposit takes place, long before the point at which the sarcosine would crystallize, of long, colourless prisms, or leaves, possessing a weakly acid reaction; they fuse and volatilize without leaving any baryta; they are easily dissolved in water and alcohol, and in about 30 parts of ether; salts of silver, protochloride of mercury, acetate of lead, salts of lime, and baryta, produce no precipitate in the aqueous solution; the quantity obtained was too inconsiderable to allow of a determination as to whether this substance corresponds, in composition, to urethane, with which it presents a great resemblance.

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and ether) of a double salt $C_6\ H_7\ N\ O_4$, H Cl, Pt $Cl_2 + 2$ HO are formed (the water escapes at 100°).—Sulphate of sarcosine, if prepared in the above-mentioned (II. p. 167) manner, dissolves when boiled in from ten to twelve times its weight of alcohol, and as the solution cools, colourless, transparent, very brilliant, four-sided plates are deposited, which are scarcely to be distinguished from those of chlorate of potassa; they dissolve with difficulty in cold alcohol, but easily in water, and crystallize from the latter in large pinnate laminæ. The aqueous as well as the alcoholic solution of this salt, has an acid reaction, so that it is difficult to determine when the free sulphuric acid has been entirely washed out. Crystallized sulphate of sarcosine is $C_6\ H_7 N\ O_4$, HO, $SO_3 + HO$ (the equiv. of water of crystallization is expelled at 100°).

If the mother-liquor of the flesh-juice be farther evaporated, after all the creatin has crystallized, and then small portions of alcohol be added until a milky turbidity is produced, yellow or white granular laminated or acicular crystals are deposited from this mixture, when allowed to stand at perfect rest for a few days; they may be, though slowly, filtered off from the mother-liquor which has now become thick, and washed with alcohol. These crystals are a mixture of various substances; they always contain creatin; if the addition of baryta did not precipitate all the phosphoric acid from the flesh-juice, the deposit also contains phosphate of magnesia; however, the main constituent is the potassa- or baryta-salt of a new acid, *inosinic acid*(1). If the exact quantity of baryta necessary to precipitate the phosphoric acid was added, the crystals contain inosinate of potassa; if the baryta was in excess, they contain inosinate of baryta, or a mixture of both salts. The deposit is to be dissolved in hot water, and chloride of barium added; on cooling, inosinate of baryta crystallizes out, and has to be recrystallized. The inosinic acid may be easily separated from the baryta-salt by dilute sulphuric acid, and from the copper-salt by sulphuretted hydrogen; the aqueous inosinic acid obtained in either way has a powerfully acid reaction, and possesses an agreeable flavour of broth; if evaporated, a syrup is formed, which presents no traces of crystallization after

(1) The temperature at which the flesh-juice is evaporated, has a great influence on the preparation of inosinates. In some cases in which the evaporating temperature never rose above 100°, no trace of them was obtained; whilst flesh-juice of the same animal yielded copious quantities of them if, during evaporation, the fluid was maintained at 50° to 60°, by means of a current of air passed over it.—Gregory (Loc. cit. II. p. 164) obtained rather more than 4 grms. of inosinate of baryta from 7 lbs. of the meat from fowls, but none from bullock's-heart, pigeon, ray, or codfish; Schlossberger (Loc. cit. II. p. 164) could obtain no inosinic acid from human muscle.

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standing for weeks; if treated with alcohol, the thick fluid is converted into a pulverulent, firm, hard mass, of which only traces dissolve in alcohol. The acid is precipitated from a concentrated aqueous solution by alcohol, in the shape of white, non-crystalline flocks; it is insoluble in ether.—In the so-called hydrated state this acid $C_{10} H_7 N_2 O_{11}$ contains the elements of anhydrous acetic acid ($C_4 H_3 O_3$), of oxalic acid ($C_4 O_6$), and of urea ($C_2 H_4 N_2 O_2$). If heated with a little peroxide of lead, dilute sulphuric acid being added, the peroxide of lead becomes white, and the filtered fluid, after being freed from the excess of sulphuric acid, deposits acicular crystals on evaporation. If mixed with nitric acid in the concentrated state, no precipitate is formed, but on evaporation, small, colourless, granular crystals are formed, which were obtained in too minute a quantity to be subjected to a closer examination.—Free inosinic acid produces no precipitate in lime-, or baryta-water; but if allowed to stand and evaporate in the atmosphere, transparent nacreous laminæ of inosinate of lime and baryta are formed. The free acid, and its soluble salts, yield, with acetate of copper, a beautifully greenish-blue precipitate of inosinate of copper, which, on being dried, forms a light-blue, amorphous powder, which is almost insoluble in water, entirely so in acetic acid, and readily soluble (with a blue colour) in ammonia. Silver-salts give a white precipitate with the inosinates; the precipitate is gelatinous, like hydrate of alumina, does not blacken, or only slightly so, on exposure to light, dissolves slightly in pure water, less readily in water containing nitrate of silver, and completely in nitric acid and in ammonia. Inosinic acid produces a white precipitate with lead-salts. The alkali-salts of inosinic acid are decomposed when heated on platinum-foil, giving rise to a strong and agreeable odour of roast meat.—The potassa-salt is obtained directly from the flesh-juice (*see* II. p. 169), or from the baryta-salt, by careful decomposition with carbonate of potassa; it is very soluble in water, and crystallizes from the solution in thin, four-sided, long prisms; it is insoluble in alcohol, and is precipitated by it even in dilute solutions (a more concentrated solution is converted, by the addition of alcohol, into a paste of fine, nacreous plates); the crystals are $KO, C_{10} H_6 N_2 O_{10} + 7 HO$; the water escapes at 100°. Inosinate of soda crystallizes in fine, silky needles, is very soluble in water, and insoluble in alcohol. Inosinate of baryta, prepared as directed above (comp. II. p. 169), is insoluble in alcohol, soluble in 400 parts of water at 16°, but more easily in hot water. If an aqueous solution, which is saturated at 70°, be heated to ebullition, a portion of the salt is precipitated as a resinous mass; boiling water does not dissolve as

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much of the salt as water at 60° to 70°, and the residue obtained, on boiling with water, if submitted to continuous ebullition, suffers some change, which causes it to be insoluble in water of a lower temperature. The crystals of the baryta-salt are elongated quadrilateral, nacreous plates, $BaO, C_{10} H_6 N_2 O_{10} + 7 HO$; they effloresce in dry air; at 100° they lose all their water, and become opaque and lustreless.—Liebig points out that the investigation of inosinic acid and its salts, is not yet to be considered as concluded, as flesh only yields so small a quantity of it.

If the flesh-juice, from which the inosinates were separated by alcohol, be treated with a farther portion of alcohol, amounting to about five-times the volume, it separates into two strata, the lower one thick, syrupy, and brownish-yellow; the upper one lighter, and of about 20 times the volume of the former. At — 5° numerous crystals of chloride of potassium are speedily deposited from the heavier portion. If the more heavy fluid be separated from the lighter portion, and treated with an equal volume of ordinary ether, it is rendered milky, and if left at rest, an amber-yellow, syrupy fluid, consisting almost entirely of lactate of potassa, collects at the bottom of the vessel. The supernatant fluid also contains some of this salt, but its chief constituent is the creatinine above spoken of. If the supernatant fluid, which contains ether and alcohol, be subjected to distillation and the residue evaporated to a slightly syrupy consistence, the latter, on cooling, solidifies into a mass of fine plates, from which the mother-liquor may be filtered off after dilution with a little alcohol. If these crystals be washed with alcohol, dried and dissolved in boiling alcohol, crystals of creatinine are at once deposited, on the cooling of the solution. The mother-liquor, when gently evaporated, yields yellowish quadrilateral tables of creatinine, which may be obtained perfectly colourless by treatment with a little hydrated protoxide of lead and animal charcoal.

If the fluid, from which the inosinates have been deposited, be evaporated in the water-bath and the residue treated with alcohol, all the lactates pass into the solution. If the alcoholic solution be separated from the insoluble syrup it contains, and the alcohol removed by evaporation, a yellow syrup remains, which after from eight to ten days solidifies into a soft crystalline mass. The crystals which have formed, consist of creatinine, creatin, the potassa-salt of a nitrogenous acid, distinct from inosinic acid; the mother-liquor contains lactate of potassa. In order to prepare the lactic acid, the entire mass is to be mixed with an equal volume of dilute sulphuric acid, (2 vols. of concentrated acid to 2 vols. of water), or with a solution of oxalic acid of similar strength (with so much of

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the latter that a crystalline deposit takes place), and this mixture at once treated with the treble or quadruple volume of alcohol. Sulphate, or oxalate of potassa is precipitated, and the lactic acid remains in solution; the fluid is mixed with ether until no turbidity is produced, then filtered, the alcohol and the ether distilled from the filtrate, and the residue concentrated to a syrupy consistence on the water-bath. Half the volume of alcohol is added to this syrup, and then five times its volume of ether, by which means an almost pure ethereal solution of lactic acid is obtained; after the ether is evaporated, milk of lime is added to the residue until a strongly alkaline reaction is produced; it is filtered, and the solution placed in a warm place, when it is soon converted into colourless crystals, appearing yellow only from the adherent mother-liquor, which is removed by washing with alcohol. In order to separate the sulphate of lime from the mass, the crystals are dissolved in spirits of wine of 60 per cent, the solution filtered, and, if coloured, treated with a little animal charcoal, when, on evaporation, pure crystals of lactate of lime are deposited.—By this method, lactate of lime may be obtained from all kinds of flesh. Fish alone renders a different mode of treatment necessary. The juice of the latter is evaporated to a syrup, and mixed with an aqueous solution of tannic acid by which a thick yellowish-white precipitate is formed, which when heated appears like pitch. The fluid separated from it is treated, as above, with sulphuric or oxalic acid, and the result is an ethereal solution of a mixture of gallic acid (formed out of the tannic acid), and of lactic acid; the former partially crystallizes out after removal of the ether. Without separating these crystals, the acid mixture is saturated with milk of lime, and filtered off from the residue which becomes dark-brown or black; the filtrate (if discoloured) is treated with animal charcoal and evaporated; after a time, perfectly white lactate of lime crystallizes out. The identity in the composition with that of lactic acid, was established by analyses of the lime-salt and of the zinc-salt; in reference to peculiarities exhibited by lactic acid obtained from flesh, when compared with common lactic acid, *see* I. p. 397.

Liebig has, finally, examined *the inorganic constituents of flesh-juice*. If the latter be evaporated without an addition of baryta, and then incinerated, an ash is obtained which it is difficult to burn white, and which consists of phosphates of the alkalies and chlorides of metals only. The soluble salts obtained from this ash contain the various modifications of phosphoric acid. The ash of the flesh-juice of the ox, the horse, the fox, and of the deer, yields a strongly alkaline solution, which is first precipitated white by neutral nitrate

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of silver and then yellow; after precipitation the mixture is completely neutral; hence the ash contains salts of phosphoric acid with 2 and 3 equivs. of alkali; the same is the case, though in a different proportion, if the ash be evaporated with nitric acid and heated to redness, the alkali of the metallic chlorides being thus added to the alkaline phosphates. The ash of flesh-juice obtained from the fowl yields an aqueous solution, with which nitrate of silver forms a pure white precipitate, and which therefore contains an alkaline pyrophosphate; even after the ash has been moistened with nitric acid and heated to redness, the aqueous solution is still precipitated white, whence it may be concluded that the flesh-juice contains also a little alkaline phosphate with 1 equiv. of base. As the flesh-juice acquires an acid reaction before the point at which the phosphoric acid is separated by baryta (at which the former consequently does not, as yet, contain any baryta), there must be present an acid lactate and an acid phosphate of alkali (the amount of inosinic acid is too trifling to be considered). Liebig appends remarks on the equilibrium between these two acids, and on the maintenance of the equilibrium in the constitution of the blood in the organism. He was unable to discover lactic acid in the urine, and arrives at the conclusion, that the lactic acid is consumed in the support of the respiratory process.

The flesh-juice of all animals is particularly rich in potassa; it contains chloride of potassium, and but little chloride of sodium; the relation is the reverse in the blood. Liebig found that the proportion of potassa to 100 parts of soda is approximatively:

	Fowl.	Ox.	Horse.	Fox.	Pike.
In the blood	40·8	5·9	9·5	—	—
In the flesh	381·0	279·0	285·0	214·0	497·0

He discusses the formation of the amount of phosphate of soda necessary for the organism of animals which only consume plants containing potassa, and the necessity for the consumption of chloride of sodium in such cases. He inquires, moreover, into the amount of carbonic acid and alkaline carbonate contained in the blood, (*see* II. p. 158). The quantity of lime contained in the flesh-juice he found to be generally very minute; in regard to the flesh-juice of the fowl alone it was determined that it contains 3·92 times more magnesia than lime. He found that in the flesh-juice of the ox the quantity of phosphoric acid, in combination with alkalies, is from 3·5 to 3·2 times more than with magnesia.

For the results which Liebig's investigations have yielded to the chemistry of food, we refer to our Report on Technical Chemistry.

Flesh-ash.

Flesh-ash.—Enderlin(1) has communicated some analytical data on the ash from the flesh of the cock, frog, and perch; he has also examined the ash of the common fly.

Animal Juices Generally.—Andral(2) has communicated observations on the acid or alkaline reaction of the fluids of the human body, and has pointed out that the peculiar reaction of each fluid, in the normal state of the body, is more constant than might be supposed.—He found the serum of the blood to be invariably alkaline. The skin secretes two fluids which have a different reaction; acid sweat and alkaline fatty matter. The clear fluid containing no corpuscles, which is secreted on healthy mucous membranes, has an acid reaction; when mixed, however, with a turbid fluid, containing corpuscles, its reaction is alkaline. Andral considers the normal reaction of the secretion of the mouth to be acid; but this may become alkaline by the admixture of saliva. The saliva and the tears he found to be invariably alkaline. Healthy urine he states to be invariably acid, or neutral, if a superabundance of water has rendered the acidity imperceptible. Andral discusses the accidental influences which may give rise to an alkaline reaction of the urine. We must content ourselves with referring the reader to the original for the details of these investigations.

We also confine ourselves to a mere mention of C. Schmidt's(3) investigations of transudation in the animal body, and the composition of the secretions dependent upon this process, referring to the treatise itself.

Liquor Amnii.—Scherer(4) found the pure liquor amnii of a five months' fœtus, a) and of a mature fœtus b) to be thus constituted:

	Albumin and mucus.	Extractive matter.	Salts, chiefly with alkaline base.	Water.
a)	7·67	7·24	9·25	975·84
b)	0·82	0·60	7·00	991·47

He found no urea in it, but he seems to think it contains creatinine.

Examination of Fluids taken from the Diseased Body.—Burguières(5) has communicated observations of the reaction of fluids obtained from the body of cholera patients. He found the normal acid reaction of the cutaneous surface cancelled, and the reaction of the stomach alkaline.

(1) Ann. Ch. Pharm. LXVII, 304.

(2) Ann. Ch. Phys. [3] XXIV, 116; Compt. Rend. XXVI, 649.

(3) Ann. Ch. Pharm. LXVI, 342.

(4) From Siebold and Kölliker's Zeitschrift für wissenschaftl. Zoologie, I, 88, in Pharm. Centr. 1848, 908.

(5) Compt. Rend. XXVII, 343.

Grassi(1) has examined the fluid taken from an hydrocele, Landerer(2) that of an hygroma found in the orbit after extirpation of an eye. Castoreum.

Castoreum.—On distilling *Castoreum Canadense* with water Wöhler(3) obtained a distillate which smelt strongly of castoreum, and slightly, but distinctly, exhibited the reaction of *carbolic acid* on the addition of sesquichloride of iron. The fluid in the distilling apparatus when filtered hot from the mass of castoreum, deposited on cooling a small quantity of a pulverulent, yellow substance, which was easily soluble in potassa, but was not farther examined; the filtered fluid contained a *benzoate* and *salicin*.

Sugar in the Liver.—Bernard and Barreswil(4) have found sugar in the liver even of animals which were exclusively fed on flesh. According to their views, the liver is the only organ of the animal body which in the healthy condition contains sugar.(5) They did not obtain the sugar in the crystallized or solid state, but proved its existence by fermentation and the isolation of the alcohol thus formed.(6)

Bile.—Several chemists have examined the bile of various animals. The bile of pigs and bullocks has been studied with particular care. We shall first report the results to which the investigation of ox-gall has led; we can then easily append the results obtained by the examination of the bile of other animals.

Ox-Gall.—Strecker(7) and Mulder(8) have published two treatises on the ox-gall.

It is well known that there were two principal views as to the constitution of the chief constituent of the ox-gall, which remains, after evaporation of the contents of the biliary vesicle, together with minute quantities of biliary mucus, fats, cholesterin, and several inorganic salts. According to Berzelius, it consists of a single

(1) J. Pharm. [3] XIV, 364.

(2) Repert. Pharm. [2] XLV, 61.

(3) Ann. Ch. Pharm. LXVII, 360; Repert. Pharm. [3] II, 90.

(4) Compt. Rend. XXVII, 514.

(5) More correctly perhaps: which yields sugar on boiling with water.

(6) Experiments conducted in the Giessen laboratory have confirmed these statements, both in reference to the liver of graminivora and carnivora.

(7) Ann. Ch. Pharm. LXV, 1; J. Pr. Chem. XLVI, 137; J. Pharm. [3] XIII, 215; Chem. Gaz. 1848, 149; Ann. Ch. Pharm. LXVII, 1; J. Pr. Chem. LXVI, 143; J. Pharm. [3] XV, 153; Laur. and Gerh. Compt. Rend. des Trav. Chim. 1849, 43; Chem. Gaz. 1849, 49, 74.

(8) Mulder has also published a critique of Strecker's investigations.

Ox-gall.

mother-substance *bilin* together with several products of its decomposition, which are partly non-nitrogenous acids as *fellinic* and *cholinic* acid, possessing the property of forming conjugate combinations, of an acid character, with bilin. These compounds, *bilifellinic* and *bilicholinic acids*, however, are so unstable that even the mere treatment with ether causes a partial separation, as the acids dissolve in ether, whilst bilin, being insoluble in it, is left as a residue. Mulder(1) has since attempted to defend this view in an elaborate investigation.—Demarçay was the first who taught another doctrine in reference to the constitution of the principal constituent of ox-gall, which has been mainly adopted by Liebig's school, viz., that it is the soda-salt of a nitrogenous acid—*choleic acid*, which after Redtenbacher's discovery of the sulphur contained in taurin proved to be a sulphur-acid.

Strecker has been led, by elaborate researches, to the conclusion that the organic constituent of ox-gall indeed possesses an acid character, but that it consists of two different substances, which, however, when decomposed, yield the same *non-nitrogenous* products on the one hand, and different *nitrogenous* substances on the other; viz., *taurin* and *glycocoll*. The two acids may therefore be looked upon as conjugated compounds of the same acid with glycocoll and taurin. We shall communicate the results of the investigation so as first to describe the acid conjugated with glycocoll (cholic acid) and its products of decomposition with alkalies and acids, and then treat of the acid conjugated with taurin (choleïc acid).

One of these acids is the *cholic acid*, which was discovered a considerable time ago by L. Gmelin, and which Strecker recommends to be prepared in the following manner: Fresh ox-gall is to be evaporated to dryness in the water-bath, and the coloured fluid treated with ether. A deep coloured, more or less syrupy deposit is thus produced, which, if left for a longer period in the fluid, is entirely, or more frequently, only partially converted into a mass of acicular crystals (Platner's crystallized bile). If the precaution be employed only to precipitate a portion, by an insufficient quantity of ether, the first deposit will be found to contain the whole of the colouring matter, and comparatively more of the sulphur-body; the alcoholic fluid, which has been decanted, yields a new, almost colourless precipitate, on the addition of more ether, which, after remaining a short time in the fluid, is transformed into a mass of acicular

(1) Scheik. Onderz. IV, 1.

crystals, grouped in rays.(1) After standing for twenty-four hours the fluid is decanted, and the precipitate washed with a mixture of alcohol and ether, and redissolved, while moist, in water. This aqueous solution, when treated with dilute sulphuric acid, yields a milky fluid, from which, after a few hours, a quantity of white needles are separated, so that the entire fluid often solidifies. There are generally some oily, coloured drops between the crystals. The mass is thrown upon a filter, washed with cold water, in which the oily drops dissolve, and the residue finally treated with boiling water, in which the chief part is dissolved, leaving small scales, which present a nacreous lustre; the fluid, after being filtered hot, solidifies into a mass of crystals, which consist of pure cholic acid. The residuary matter on the filter is an insoluble modification of cholic acid, which may be reconverted into cholic acid by solution in alcohol, and precipitation by the addition of water. Strecker calls it *paracholic acid*. There is another method of preparing cholic acid, which resembles the one given by L. Gmelin; for this purpose the precipitate obtained from fresh ox-gall, by solution of acetate of lead, is employed; it is suspended in water (Mulder), or acetic acid (L. Gmelin), or finally, it is dried and dissolved in alcohol (Strecker), and decomposed with sulphuretted hydrogen. In the two former cases the sulphide of lead is first washed with cold, and then with boiling water; in the latter case, however, the alcoholic fluid is filtered, and the sulphide of lead washed with water, which is allowed to run into the alcoholic liquid; the milky solution, on being left to stand, deposits crystals of cholic acid. The cholic acid, however, thus obtained, contains ammonia according to Mulder, and has to be freed from it by solution in baryta-water. Ox-gall.

Cholic acid forms delicate, white needles, which scarcely present a diameter even when magnified 300 times; when collected on the filter they are at first very voluminous, but gradually contract into a silky leaf. 1000 parts of cold water dissolve 3·3 parts of acid, 1000 of boiling water dissolve 8·3 parts. The aqueous solution has a sweet and slightly bitter taste; it possesses an acid reaction, and only yields a precipitate with basic acetate of lead. The acid is very easily soluble in alcohol, and when evaporated at a gentle temperature, is left as a resinous mass. The alcoholic solution is converted, by water, into a milky fluid, which may be filtered, and becomes

(1) Platner (J. Pr. Chem. XL, 129) allows the crystals to be deposited in the cold from the decanted alcoholic fluid without again adding ether.

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clear after several hours, acicular crystals being deposited. The acid is slightly soluble in ether, but is precipitated by ether only with difficulty from its alcoholic solution. It is very soluble in cold sulphuric, in hydrochloric, and acetic acids; when the solution is boiled with mineral acids, a resinous precipitate is formed. The acid is easily dissolved by the fixed alkalies, ammonia, and baryta-water; on the addition of acetic acid, it is reprecipitated in the amorphous condition. Cholic acid may be obtained in three modifications; one has been just described, the second is the amorphous precipitate mentioned, which crystallizes if left in the fluid, but more rapidly on the addition of ether; the third is *paracholic acid* (comp. p. 177), which crystallizes in the shape of nacreous laminæ, and appears, when seen under the microscope, to consist of hexagonal tables, in which the two opposite sides are much larger than the remainder. Paracholic acid is insoluble in water; when dissolved in alcohol, or alkalies, it passes into ordinary cholic acid, which, on being boiled with water again, partially yields paracholic acid.

In reference to the chemical formulæ of cholic acid, and its products of decomposition, Strecker and Mulder adopt different views, the latter assuming 54, the former 52 equivs. of carbon in cholic acid,—a difference which recurs in all the products of decomposition. For the sake of comparison we quote both formulæ, together with the analytical results(1): the two chemists do not differ much in regard to the latter.

Composition of cholic acid:

	Carbon.	Hydrogen.	Nitrogen.	Oxygen.
$C_{54}H_{44}NO_{13}$ (Mulder)	66·6	9·0	2·9	21·5
$C_{52}H_{43}NO_{12}$ (Strecker)	67·1	9·3	3·0	20·6
3 experiments (Mulder)	66·5—66·8 (66·6)	9·2—9·3 (9·3)	3·2—3·3 (3·3)	—
9 ditto (Strecker)	66·8—67·4 (67·1)	9·2—9·4 (9·3)	2·7—3·2 (3·0)	—

Cholic acid forms, with the alkalies and alkaline earths, salts that are easily soluble in water, with the heavy metallic oxides, salts which are insoluble or difficultly soluble in water; all its salts are soluble in alcohol. The salts may, for the most part, be prepared in the crystallized, as well as in the amorphous condition; the former is obtained best by precipitating the alcoholic solution with ether, the latter by evaporating the solution, or precipitating the aqueous solution.—*Cholate of soda* is obtained by dissolving cholic acid in carbonate of soda, until the solution is neutralized, and evaporating.

(1) The numbers contained in brackets represent the calculated average of the analyses.

It is precipitated, as an amorphous mass, from the aqueous solution by soda, or by concentrated carbonate of soda. The salt is separated from the alcoholic solution by ether, in the shape of stellar, white needles. It fuses when heated, and burns with a sooty flame, leaving an easily fusible ash of alkaline reaction, containing cyanate of soda. According to Mulder, this salt does not become anhydrous under a temperature of 130°, a statement not agreeing with Strecker's analyses, which refer to a salt dried at 100°. The composition of the cholate of soda is 1) according to Mulder, 2) according to Strecker:

	Carbon.	Hydrogen.	Nitrogen.	Oxygen.	Soda.
1) $C_{54} H_{43} N O_{12}$, NaO	63·7	8·5	2·8	18·9	6·1
2) $C_{52} H_{42} N O_{11}$, NaO	64·1	8·6	2·9	18·0	6·4
3 experiments (Strecker)	63·8—63·9	8·7—8·8	—	—	6·1—6·2 (6·2)
1 experiment (Mulder)	64·1	8·7	—	—	6·3

The *potassa-salt* of cholic acid resembles the soda-salt in every respect.—Strecker obtains neutral *cholate of ammonia* by conducting dry ammoniacal gas into an alcoholic solution of the acid; after a time, or on the addition of ether instantly, a formation of acicular crystals takes place. They lose their ammonia even when dried *in vacuo*, and assume an acid reaction; the same occurs when the aqueous solution is boiled. Mulder found that when he conducted dry ammoniacal gas, and then common air at 100°, for one hour, over cholic acid, there was an increase of weight to the amount of 1·6 per cent, from which he concludes the existence of an acid ammonia-salt.—*Cholate of baryta* is obtained by dissolving cholic acid in a solution of baryta, into which carbonic acid is conducted; the solution is evaporated to dryness, when the salt remains as a white amorphous mass. For the purpose of analysis it was redissolved in absolute alcohol, in which, however, it is much less soluble than in water; 1000 parts of water at 15°, dissolve 162 parts of the baryta-salt.

Composition of cholate of baryta:

	Carbon.	Hydrogen.	Nitrogen.	Oxygen.	Baryta.
$C_{54} H_{43} N O_{12}$, BaO (M.)	58·5	7·9	2·5	17·2	13·8
$C_{52} H_{42} N O_{11}$, BaO (Str.)	58·6	7·9	2·6	16·5	14·3
1 experiment (Mulder)	58·6	8·0	—	—	14·1
3 experiments (Strecker)	58·2; 58·2; 58·4	8·0; 8·1; 8·1	—	—	14·3; 14·3; 14·4

Mulder states, that the salt that has been dried at 100° loses as much as 0·8 per cent of water ($\frac{1}{2}$ equivalent) at 130°; Strecker dried the salt at 100°.

Mulder has also prepared *cholate of lead*, by dissolving cholic acid in an excess of carbonate of soda and reprecipitating with acetate of lead. It was then dissolved in alcohol and reprecipitated by water.

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Mulder proposes for it the formula $PbO, C_{54} H_{43} N O_{12}$, ; the amount of protoxide of lead found (18·3 per cent) deviates too much from the calculated amount (18·9) to give weight to the analysis.

Products of the decomposition of cholic acid by the alkalies. If cholic acid be boiled for a considerable time with a hot saturated solution of hydrate of baryta, it is decomposed, according to Strecker's statement, being split into a non-nitrogenous acid termed cholalic acid, and *glycocoll.* In order to insure complete decomposition the boiling must be continued for twelve hours or more; the solution of baryta remains quite clear, and solidifies, on cooling, into a crystalline mass. If the decomposition be conducted in a retort with a receiver, a slight evolution of ammonia is continuously observed, and the distilled water holds a small quantity of an offensively smelling body in solution. Both substances are said to be secondary products of the glycocoll. Cholalic acid and glycocoll are obtained from the residue in the retort in the following manner: it is washed with boiling water, and the residuary cholalate of baryta decomposed with hydrochloric acid, by which the cholalic acid is caused to separate in the shape of a resin. The fluid filtered from the cholalate of baryta and the washings are separated from the excess of baryta by a current of carbonic acid; hydrochloric acid is then added to the filtered solution, by which means another portion of cholalic acid is separated; lastly, the baryta is precipitated from the solution by sulphuric acid. The hydrochloric and sulphuric acids are removed by boiling with hydrated protoxide of lead, and finally, the lead in solution precipitated by sulphuretted hydrogen; if the solution be now evaporated, prismatic crystals of glycocoll are deposited.—Strecker has established the identity of the substance obtained from cholic acid with glycocoll by comparing their properties and by analysis.

The non-nitrogenous acid which presents itself in this decomposition at the same time as the glycocoll, and which Strecker terms *cholalic acid* is identical with Demarçay's cholic acid, which the latter chemist obtained by boiling ox-gall with potassa. It has been stated above in what manner it was separated from baryta; the precipitated resinous matter is allowed to remain in the fluid until it has become hard and friable; it is then washed with cold water, and dissolved in boiling alcohol, from which it crystallizes on cooling.

The cholalic acid crystallized out of alcohol presents square pyramids with truncated lateral corners, or tetrahedrons of the square-prismatic system with truncated lateral edges, in which H. Kopp finds the relation of the principal axis to a secondary axis to be = 0·7946 : 1. The crystals are colourless, vitreous, friable; in dry

atmospheric air they lose their water, and become opaque and white. They require 750 parts of boiling and 4000 of cold water for their solution. They have a bitter taste with a slightly sweet after-taste. They dissolve copiously in boiling alcohol, cold alcohol of 70 per cent dissolves 4·8 parts of acid. When water is added the alcoholic solution becomes milky, and when allowed to stand at rest, deposits acicular, bright crystals, generally mixed with tetrahedrons. The acid requires 27 parts of ether for its solution. The crystals which are deposited from the ethereal solution are rhombic tables of the right-rhombic system. H. Kopp gives a description of them. The various crystalline forms depend upon the amount of water of crystallization present; the acid crystallized in the square-prismatic system possesses the formula $C_{48}\ H_{40}\ O_{10} + 5\ HO$, the crystals of the rhombic system $C_{48}\ H_{40}\ O_{10} + 2\ HO$; the former loses all its water of crystallization at 100°, the latter only 1 equivalent of water at the same temperature.

The composition of cholalic acid is expressed according to Strecker by the formula $C_{48}\ H_{40}\ O_{10}$. Mulder, without himself making experiments, has given $C_{100}\ H_{81}\ O_{21}$, as the formula of the acid. Mulder has not proposed any formulæ for the salts of this acid; for the sake of comparison we also communicate the composition of the acid, as calculated from Mulder's assumed formula.

	Carbon.	Hydrogen.	Oxygen.
$C_{100}\ H_{81}\ O_{21}$ (Mulder)	70·6	9·5	19·9
$C_{48}\ H_{40}\ O_{10}$ (Strecker)	70·6	9·8	19·6
4 experiments (Strecker)	69·9—70·8 (70·4)	9·7—10·0 (9·9)	—

Cholalic acid dissolves easily in dilute solutions of the alkalies or their carbonates, and when the solutions are evaporated, the salts are left in the crystalline form. The aqueous solution of cholalate of potassa which contains 3 per cent of cholalic acid yields no precipitate with chloride of barium, a pasty thick precipitate with chloride of calcium, with solution of copper a bluish-white, with protoxide of manganese a white semi-crystalline precipitate; white precipitates are formed with protochloride and solutions of suboxide of mercury, and of silver, which are partially dissolved by boiling. All the salts of cholalic acid are soluble in alcohol. They possess a strongly bitter, and at the same time slightly sweet flavour. When heated with a solution of sugar and concentrated sulphuric acid, they present the same violet colour as cholic acid. —The *potassa-salt* is precipitated from the alcoholic solution by ether in acicular crystals; it also crystallizes when the alcoholic

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solution is evaporated. The aqueous solution of the salt is precipitated by strong potassa.

Composition of cholalate of potassa:

	Carbon.	Hydrogen.	Oxygen.	Potassa.
$C_{100}\ H_{79}\ O_{19}$, 2 KO (M.)	64·9	8·5	16·4	10·2
$C_{48}\ H_{36}\ O_9$, KO (Str.)	64·6	8·7	16·1	10·6
Experiment (Strecker)	63·9; 64·0	8·7; 8·8	—	10·5; 11·2

The *soda-salt* resembles the potassa-salt very closely.—The *ammonia-salt* was prepared in the same way as cholate of ammonia; the ammonia is gradually lost by boiling as well as on mere exposure to the atmosphere.—In order to prepare the *baryta-salt* the cholalic acid is dissolved in baryta-water, the excess of baryta precipitated by carbonic acid and the solution evaporated, when it becomes covered with a crystalline pellicle of cholalate of baryta, the inferior surface of which presents a silky appearance, the superior a warty aspect. The salt requires for its solution 30 parts of cold and 23 of boiling water; it is more soluble in alcohol. Both the aqueous and the alcoholic solution of this salt are decomposed by a continuous current of carbonic acid.

Composition of the baryta-salt dried at from 100° to 150°.

	Carbon.	Hydrogen.	Oxygen.	Baryta.
$C_{100}\ H_{79}\ O_{19}$, 2 BaO (M.)	61·0	8·0	15·5	15 5
$C_{48}\ H_{39}\ O_9$, BaO (Str.)	60·6	8·2	15·1	16·1
4 experiments (Strecker)	59·9—60·3 (60·1)	8·2—8·3 (8·2)	—	15·9—16·2 (16·1)

The *lime-salt* is obtained by precipitation in the shape of a thick curdy precipitate, which crystallizes on the addition of ether. A determination of lime led to the formula $CaO, C_{48}\ H_{39}\ O_9$. The *silver-salt* is very soluble in water, it crystallizes on cooling; at a temperature of 100° it gradually blackens.

The reaction which takes place when cholic acid is decomposed by alkalies or alkaline earths may be expressed by the following equations:

$$C_{52}\ H_{43}\ N\ O_{12} + 2\ HO = C_{48}\ H_{40}\ O_{10} + C_4\ H_5\ N\ O_4 \text{ (Strecker).}$$
$$C_{54}\ H_{44}\ N\ O_{13} + 1\tfrac{1}{2}\ HO = C_{50}\ H_{40\frac{1}{2}}\ O_{10\frac{1}{2}} + C_4\ H_5\ N\ O_4 \text{ (Mulder).}$$

These equations equally speak for the formula of Strecker, inasmuch as by the latter the decomposition of cholic acid becomes analogous to that of hippuric acid into benzoic acid and glycocoll in which, likewise, 2 equivalents of water are assimilated.

Decomposition of cholic acid by acids. The solution of cholic acid in concentrated hydrochloric or sulphuric acid when heated becomes turbid and oily drops separate, which on cooling become

solid and resinous. This mass consists of a new acid which forms soluble salts with the alkalies, insoluble salts with the alkaline earths. The solutions of the new acid in potassa or ammonia are distinguished, moreover, from those of cholic acid, by their being precipitated by chloride of ammonium as well as by numerous saline solutions. Strecker is of opinion, that according to the duration of the boiling, two acids may be formed; but it is not impossible that the differences found in analysis are due to varying temperatures employed for drying. Strecker gives the following formulæ for the two acids $C_{52}\,H_{41}\,N\,O_{10} = C_{52}\,H_{43}\,N\,O_{12} - 2\,HO$, and $C_{52}\,H_{39}\,N\,O_8 = C_{52}\,H_{43}\,N\,O_{12} - 4\,HO$. The former acid seems to have been subsequently obtained, also, by Mulder, by suspending the lead-precipitate from ox-gall in water, decomposing it with sulphuretted hydrogen, and then treating the residue with alcohol. The alcoholic solution was precipitated by water, the crystalline separated from the resinous portion of the precipitate, by stirring it up with water, and lastly the crystals purified by solution in alcohol and reprecipitation by water. In order to remove all admixture of paracholic acid, the acid must be treated with solution of baryta, with which it forms a precipitate insoluble in water; this is decomposed by hydrochloric acid, and the separated acid crystallized out of alcohol in transparent, brilliant needles. Mulder terms this acid *cholonic acid*, he does not appear to have noticed that Strecker had formerly obtained the same acid, though only in the amorphous state. The composition of this acid is:

	Carbon.	Hydrogen.	Nitrogen.	Oxygen.
$C_{54}\,H_{42}\,N\,O_{11}$ (Mulder)	69·2	9·0	3·0	18·8
$C_{52}\,H_{41}\,N\,O_{10}$ (Strecker)	69·8	9·2	3·1	17·9
2 experiments (Strecker)	70·5; 70·6	9·4; 9·5	—	—
4 „ (Mulder)	69·1—69·5 (69·4)	9·3—9·6 (9·4)	3·2; 3·4	—

Cholonate of soda is the only salt of this acid which has been examined. Mulder prepared it by the same method as he adopted for that of cholate of soda; he obtained it in crystals. Its composition is:

	Carbon.	Hydrogen.	Nitrogen.	Oxygen.	Soda.
$C_{54}\,H_{41}\,N\,O_{10}$, NaO (Mulder)	66·1	8·4	2·8	16·4	6·3
$C_{52}\,H_{40}\,N\,O_9$, NaO (Strecker)	66·5	8·5	2·9	15·5	6·6
Experiment (Mulder)	66·2; 65·9	8·9; 9·0	2·6	—	6·7; 6·6

Choloïdic acid. This acid is formed, as the experiments of Strecker prove, from cholic acid, if, after the last acid has been formed by boiling with hydrochloric acid, the ebullition be continued. The precipitate, which at first is almost fluid, when boiled continuously with concentrated hydrochloric acid, gradually becomes more firm,

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and at last remains quite solid in the boiling fluid. The substance is first washed with water, and then dissolved in alcohol; this solution is precipitated by water; the precipitate is again dissolved in alcohol, and reprecipitated by ether. Choloïdic acid thus obtained is firm, white, generally rather yellowish, and pulverizable; it fuses in boiling water without being dissolved. Once dried, it does not fuse till it reaches the temperature of 150°. In alcohol it is very soluble, the addition of water renders the solution milky, and separates the acid as a resinous mass. The acid is but slightly soluble in ether. Choloïdic acid has an acid reaction; it combines with bases, and expels carbonic acid when heated with the alkaline carbonates. The weakest acids, even carbonic acid, separate choloïdic acid from the aqueous solutions of the salts. The salts have a pure, bitter taste, and cannot be obtained in the crystalline form. The alkaline salts are soluble in water and alcohol, and insoluble in ether; with the earths and heavy metallic oxides, the acid forms salts which are insoluble in water, but which all dissolve in alcohol.

Composition of choloïdic acid(1):

	Carbon.	Hydrogen.	Oxygen.
$C_{100}\,H_{79}\,O_{19}$ (Mulder)	72·1	9·5	18·4
$C_{48}\,H_{39}\,O_{9}$ (Strecker)	72·2	9·8	18·0
Experiment (Strecker)	71·9; 72·0	9·8; 9·8	—

The *baryta-salt* of the acid was obtained by precipitating the alcoholic solution of the acid with solution of baryta, and redissolving in alcohol.

Composition of the salt when dried at 120°:

	Carbon.	Hydrogen.	Oxygen.	Baryta.
$C_{48}\,H_{39}\,O_{9}$, BaO (Strecker)	60·6	8·2	15·1	16·1
Experiment (Strecker)	60·4	8·3	—	16·1

The fluid containing hydrochloric acid, from which the choloïdic acid has been separated, when evaporated to dryness, leaves a crystalline residue of hydrochlorate of glycocoll. The splitting up of cholic acid into choloïdic acid and glycocoll, may, if the intermediate products be neglected, be expressed by the equation, $C_{52}\,H_{43}\,N\,O_{12} + HO = C_{48}\,H_{39}\,O_{9} + C_{4}\,H_{5}\,N\,O_{4}$. The same acid may also be obtained from cholalic acid, if the latter be boiled with strong hydrochloric acid, or heated to 200°, in which case 1

(1) Gerhardt (in Gerhardt and Laurent's Compt. Rend. des Trav. Chim. 1849, 48) writes the formula of this acid $C_{48}\,H_{38}\,O_{8} + HO$, and that of its salts, $C_{48}\,H_{37}\,O_{7}$, $MO + HO$.

equiv. of water (found 2·2 and 2·4 per cent, calculated 2·2 per cent) is expelled. Ox-gall.

Dyslysin. If choloïdic acid be boiled for some time in fuming hydrochloric acid, it is still farther decomposed. The resinous matter obtained after ebullition for twelve hours, no longer fuses in boiling water; it is insoluble in cold, slightly soluble in boiling alcohol, easily so in ether. When boiled with an alcoholic solution of potassa, or when fused with hydrate of potassa, the *dyslysin* thus obtained, is reconverted into choloïdic acid. It always has more or less of a brown colour; it is obtained in the purest state by dissolving it in ether, and precipitating by an addition of absolute alcohol. The composition of this body is:

		Carbon.	Hydrogen.	Oxygen.
$C_{100}\ H_{73}\ O_{13}$	(Mulder)	77·2	9·4	13·5
$C_{48}\ H_{36}\ O_{6}$	(Strecker)	77·4	9·7	12·9
2 experiments	(Strecker)	77·6; 77·3	9·7; 9·6	—
2 „	(Mulder)	76·9; 77·0	9·6; 9·5	—

Dyslysin may, according to Strecker, be also formed by heating choloïdic acid to from 300° to 310°; in this case also it is rendered brown.

The formation of dyslysin from choloïdic acid, may be explained by the elimination of 3 equivs. of water. It is evident that the acid properties of cholalic acid diminish in proportion as water is eliminated; the dyslysin, at last, becomes incapable of combining with bases.

We now arrive at the consideration of the second acid contained in ox-gall (comp. II. p. 176), termed by Strecker *choleïc acid.*— There is in ox-gall, besides cholic acid, a considerable amount of an organic substance, which is not precipitated either by acids, or neutral acetate of lead. This is the substance which Berzelius called *bilin.* According to Strecker's investigation, however, it possesses the properties of an acid, inasmuch as it is capable of forming combinations with the alkalies, which have no reaction upon vegetal colours, and of uniting with metallic oxides. These combinations are, however, for the most part, soluble in water, so that the solution of this substance yields no precipitate with most metallic solutions (with the exception of basic acetate of lead, f. i.). The acid itself is soluble both in alcohol and water; it possesses the property of dissolving cholic acid, so that Strecker was unable to obtain it in the pure state from ox-gall. Strecker terms this acid choleïc acid, and according to him it is, with the exception of cholic acid, the only organic substance contained in the precipitate formed by ether in the alcoholic solution of bile. Strecker has promulgated the opinion that

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this acid is a conjugated combination of cholalic acid and taurin; he founded this view chiefly upon the observation, that the precipitate produced in ox-gall by basic acetate of lead, which, in addition to cholic acid, contains another, sulphurated, acid, when decomposed with boiling concentrated baryta-water, yields only cholalic acid, in addition to glycocoll and taurin. Part of the cholalic acid thus obtained was united with glycocoll, the other portion with taurin. The identity of the acid thus obtained, with the cholalic acid derived from cholic acid, was proved by the analysis of the acid, as well as of the baryta-salt. Strecker gives, for choleïc acid, the formula $C_{52} H_{45} N O_{14} S_2 = C_{48} H_{40} O_{10} + C_4 H_7 N O_6 S_2 - 2 HO$; in support of which he quotes the analogy with cholic acid, the inability of taurin, as such, to form saline combinations, and, finally, the analyses of various cholic and choleïc acid salt-mixtures.—Choleïc acid possesses, according to Strecker, the following properties: the acid is soluble in water and alcohol, insoluble in ether; its solution cannot be evaporated to dryness without being decomposed, the commencement of which process is rendered perceptible by dilute mineral acids producing a precipitate. When in combination with bases, this acid possesses greater stability; its salts with an alkaline base are soluble in water and alcohol, insoluble in ether, and have no action upon vegetal colours; in a moist atmosphere they absorb water, but without deliquescing; when in contact with ether they are converted, after a considerable period, into a mass of radiated crystals. The salts, when heated, swell up; they burn with a sooty flame, and leave an easily fusible ash. They have a sweet taste, terminating in a bitter flavour; the aqueous solution is not precipitated by addition of acids, not even of concentrated sulphuric acid. When boiled, the solution, which has been treated with an acid, becomes turbid, and choloidic acid is separated; the fluid, after this, contains taurin in solution. Concentrated solutions of hydrate, or carbonate of potassa, completely separate the potassa-salt of the acid in an aqueous solution of salts of choleïc acid. Neutral solutions of choleïc acid yield no precipitates with solutions of the alkaline earths, nor with the solutions of the heavy metallic oxides. Basic acetate of protoxide of lead causes the formation of white flocks, which combine, so as to form a pasty mass; the precipitate is completely dissolved in a large amount of boiling water, this being effected still more easily in an excess of acetate of lead. After precipitation by basic acetate of lead, a new precipitate is formed on the addition of ammonia, but a considerable portion of choleic acid still always remains in solution.

Ox-gall.

The solutions of choleates do not form precipitates either with copper-, or silver-solutions, nor with solutions of protochloride of mercury; a small quantity of sesquichloride of iron yields a precipitate which is soluble in an excess; nitrate of suboxide of mercury, or protochloride of tin, yields white flocks.—Choleïc acid, like cholic acid, affords the reaction, discovered by Pettenkofer, with sugar and sulphuric acid.—When decomposed by boiling with hydrate of baryta, or potassa, it yields cholalic acid and taurin. When decomposed with boiling hydrochloric acid, taurin and choloïdic acid result, or if the ebullition be long continued, dyslysin is formed. It follows that it is constituted similarly to cholic acid; both may be considered as conjugated combinations of cholalic acid, on the one hand with glycocoll (cholic acid), on the other, with taurin (choleïc acid).

All the peculiarities of choleïc acid above-stated, were established by studying the acid contained in fish-gall; this species of bile contains, as Strecker(1) has demonstrated, scarcely anything but choleates. The choleïc acid contained in ox-gall cannot be obtained free from cholic acid; once mixed, the two acids can no longer be completely separated; we never succeed in precipitating the choleïc acid by metallic solutions, without at the same time precipitating some cholic acid, nor in precipitating the cholic acid completely in combination with metallic oxides, so that none of it remains together with the choleïc acid still held in solution. The choleïc acid may, however, be separated pretty completely from the cholic acid, by partly precipitating an alcoholic solution of ox-gall with ether, redissolving the precipitate first formed, which principally contains choleates, in alcohol, and repeating this operation. A trifling admixture of cholic acid does not change the reactions of choleïc acid.

Strecker has endeavoured to demonstrate that the main constituent of ox-gall, which is soluble in alcohol, and is precipitated by ether, contains no other constituents besides salts of cholic and choleïc acids. He quotes a considerable number of analyses of this main constituent of ox-gall, as well as of various combinations of protoxide of lead, potassa, and baryta, prepared with it, from which it follows that for 1 equiv. of base there are 52 equivs. of carbon, and from 42 to 44 of hydrogen (or in the basic lead-salts there are 52 equivs. of carbon to $2\frac{1}{2}$ of protoxide of lead). He calculates various salts, in which the amount of sulphur was determined as

(1) Liebig, Poggendorff and Wöhler's Handwörterbuch der Chemie, III, 249.

Ox-gall. mixtures of choleates and cholates, and the results he thus arrives at correspond pretty well with the analytical numbers. We refer to the treatise itself for the details.

Besides ox-gall, the gall of various other animals has been subjected to analysis.

Examination of Pig's Gall.—Gundelach and Strecker(1) have examined pig's bile, and have found it to differ in many respects from ox-gall. It is long known from Thenard's investigation that pig's bile is precipitated by acetic acid, and most recently Gorup-Besanez(2) has arrived at the conclusion that the acid contained in the pig's bile is choloïdic acid, and consequently free from sulphur and nitrogen. Gundelach and Strecker have recognised the main constituent of this bile to be the alkali-salt (chiefly a soda-salt) of a peculiar nitrogenous acid, to which they have given the name *hyocholic acid* (from ὗς, ὑός and χολή). Fresh pig's bile when evaporated at 100° leaves an average residue of 11·2 per cent, small quantities of ammonia and of a volatile disagreeably smelling substance being given off. When treated with absolute alcohol this residue is for the most part dissolved, and only about 5·3 per cent of it remain (chiefly mucus of the biliary vesicle). The alcoholic, yellowish-brown solution yields on the addition of ether a coloured resinous precipitate amounting to about 75 per cent of the dry gall-residue, which consists chiefly of hyocholate of soda. In the alcoholic and ethereal mixture cholesterin and fats are held in solution in addition to a portion of the soda-salt. By treating the alcoholic solution with animal charcoal, the colouring matter may for the greater part, but not entirely, be removed.

In order to prepare the *hyocholate of soda* in a pure state, fresh pig's bile is to be digested with sulphate of soda, when in proportion as the latter dissolves the hyocholate of soda which is insoluble in concentrated saline solutions, separates, in combination with a little yellow colouring matter and mucus. The precipitate is washed with a concentrated solution of sulphate of soda, dried and dissolved in absolute alcohol. The solution which has but a slight tinge may be completely decolourized by animal charcoal, and on the addition of ether yields a perfectly white precipitate of hyocholate of soda. This is amorphous, easily soluble in water and alcohol, and of an extremely bitter flavour. When heated it swells up and fuses, and burns with

(1) Ann. Ch. Pharm. LXII, 25; Ann. Ch. Phys. [3] XXII, 38; J. Pharm. [3] XIII, 145.

(2) Ann. Ch. Pharm. LIX, 156.

Examination of pig's gall.

a sooty flame. The aqueous solution yields precipitates with the majority of metallic salts. The precipitates obtained with lime- and baryta-salts dissolve when boiled with a large quantity of water. The precipitate produced by neutral acetate of lead does not cake on boiling; after it has subsided, a new precipitate is formed on the addition of ammonia. It is worthy of remark that hyocholate of soda may be precipitated by numerous saline solutions. Thus a concentrated solution of hyocholate of soda yields flocculent precipitates which contain hyocholic acid in combination with the superadded base, with solutions of potassa or soda, of the carbonates or sulphates of potassa, soda, or ammonia, with chloride of sodium, of ammonium, &c. The precipitate obtained with the solution of chloride of ammonium is cited as peculiarly characteristic, inasmuch as it differs from the others by presenting a crystalline appearance under the microscope. When heated with sulphuric acid and sugar the hyocholates yield a purple fluid.

The *potassa-salt* was obtained in flocks by dissolving the acid in weak potassa, and adding sulphate of potassa; the flocks were washed with sulphate of potassa, dissolved in absolute alcohol, and precipitated with ether. They form an amorphous white mass which behaves in the same way as the soda-salt, and possesses an analogous constitution.—The *ammonia-salt* may be prepared like the preceding one; it readily loses a portion of the ammonia and assumes an acid reaction.—The *baryta-salt* is obtained as a white rather gelatinous precipitate, by precipitating the soda-salt or the decolourized pig's gall with chloride of barium; it is hardly soluble in water, easily in alcohol.—The *lime-salt* may be obtained colourless also from coloured pig's gall by precipitation with chloride of calcium, if the precaution be adopted not to complete the precipitation, as the colouring matter falls last. It is rather more soluble in water than the baryta-salt; its alcoholic solution is precipitated by carbonic acid.—If the soda-salt be precipitated with neutral acetate of lead, a basic salt results, the fluid assuming an acid reaction and yielding a fresh precipitate on the addition of ammonia.—The *silver-salt* is obtained by double decomposition in the shape of a gelatinous precipitate which becomes flocculent on boiling, without blackening, unless the fluid contains an excess of nitrate of silver. It is hardly soluble in water, but easily so in alcohol.

Hyocholic acid is separated from the soda-salt by dilute sulphuric acid, the fluid becoming milky, and after a short time depositing the acid in drops. The latter forms a white resinous mass melting

Examination of pig's gall.

in hot water and capable of being drawn out in threads. When dried it continues hard at 120°, and only melts at a higher temperature. Though slightly soluble in water, it is rapidly taken up by alcohol; the acid is not entirely insoluble in ether. It has an acid reaction, dissolves easily in ammonia, and in dilute solutions of caustic and carbonated alkalies; it is not dissolved when strong potassa is poured over it, but absorbs potassa and then dissolves in pure water.

The analysis of the salts dried at from 100° to 120° led to the formula $C_{54}\ H_{43}\ N\ O_{10}$, MO, and the combustion of hyocholic acid yielded the formula $C_{54}\ H_{43}\ N\ O_{10}$. Gundelach and Strecker accordingly consider the acid as anhydrous, Gerhardt(1), on the contrary, assumes 1 equivalent of water of crystallization in all the salts, and writes their formula $C_{54}\ H_{42}\ N\ O_9$, MO + HO.

Hyocholic acid is a substance which is attacked with difficulty by reagents; it is dissolved by fuming nitric acid, with disengagement of heat and of red fumes, and the same volatile products are formed which Redtenbacher obtained by the reaction of nitric acid upon choloïdic acid, viz., a heavy oily fluid of a penetrating odour, which yields yellow crystals with potassa (nitrocholate of potassa), and volatile fatty acids of the series $C_n\ H_n\ O_4$. The non-volatile products of this oxidation are oxalic and cholesteric acid, consequently just the same as those yielded by choloïdic acid. It follows that hyocholic acid stands in a close relation to the constituents of ox-gall. Strecker(2) has since pointed out that the acid obtained by treating cholic acid for a short time with hydrochloric acid (II. p. 183), which Mulder terms *cholonic acid*, possesses the formula $C_{52}\ H_{41}\ N\ O_{10}$, which differs by $C_2\ H_2$ from the formula of hyocholic acid. The analogy between the latter acid and cholic acid is also supported by the fact that, as Strecker(3) remarks, the former, when treated with concentrated hydrochloric acid, as well as with alkalies, is split up into glycocoll and a non-nitrogenous body. When boiled with potassa, an acid is formed, which is soluble in ether and crystallizes out of it in warty granules; it is distinct from cholalic acid.—By the oxidation of hyocholic acid with bichromate of potassa and sulphuric acid, Gundelach and Strecker obtained hydrocyanic acid, in addition to volatile and fatty oils in the distillate.

(1) J. Pharm. [3] XIII, 145.
(2) Ann. Ch. Pharm. LXV, 36.
(3) Liebig, Poggendorff and Wöhler's Handwörterbuch der Chemie, III, 250.

Examination of pig's gall.

The portion of pig's gall which is soluble in alcohol and can be precipitated by ether, contains, in addition to hyocholic acid, a sulphurated substance. Gundelach and Strecker found 0·47 per cent, Bensch(1) 0·3 per cent of sulphur, in the portion that was thus precipitated. The former chemists were unable to prepare taurin by decomposing pig's gall with acids. Strecker has, however, since stated, that after treating pig's gall with hydrochloric acid, the mother-liquor, from which the glycocoll had for the most part crystallized, when burnt with nitrate of potassa and potassa, presented a slight reaction of sulphuric acid; he therefore concludes that it contained a small portion of taurin. Mulder(2) states, that according to experiments, not yet published, of von Heijningen and Scharlée, taurin may be as easily prepared from pig's gall as from ox-gall.

Strecker has expressed the opinion, that the difference in the gall of various classes of animals is based upon the different proportion of conjugated taurin- and conjugated glycocoll-combinations (choleïc and cholic acid) which they contain in combination with bases; he considers that the relation of the two main constituents varies very little in the same class. He has proved by experiments, that sheep's gall contains chiefly choleïc acid, and only a small amount of cholic acid. When treated with hydrate of baryta, it yielded cholalic acid and taurin, with a trifling admixture of glycocoll. The gall of various salt-water fishes, *e. g.*, cod (*Gadus Morrhua*) and turbot (*Pleuronectes maximus*), when purified with alcohol and ether, behaves, according to Strecker's statement, exactly like a salt of choleïc acid, and on decomposition with hydrate of baryta, yields, in addition to cholalic acid, taurin which scarcely contains a trace of glycocoll. Pig's gall, accordingly, is the only gall which has hitherto been found to contain a non-nitrogenous acid distinct from cholalic acid (p. 189 *et seq.*)

Examination of the Gall of various Animals.—Bensch(3) has analysed the gall of various animals, and has attempted chiefly to determine the amount of sulphur contained in them. For this purpose, he did not employ the entire bulk of the gall, but only that part which was soluble in alcohol and insoluble in ether (according to

(1) Loc. cit. sub (3).

(2) Scheik. Onderz. V, 84.

(3) Ann. Ch. Pharm. LXV, 194; J. Pr. Chem. XLVI, 255; J. Pharm. [3] XIII, 320.

Examination of the gall of various animals.

Strecker, the mixture of cholates and choleates). This portion was dried at a temperature of 100°; the following are the results of the analyses calculated for 100 parts(1):

	Carbon.	Hydrogen.	Nitrogen.	Sulphur.	Ash.
Calves' gall	55·4	7·7	3·3	4·9	13·15
Sheep's gall	57·3	7·8	3·9	5·7; 5·3	11·86
Goat's gall	57·3	8·2	—	5·2	13·21
Bear's gall	57·7	8·3	—	5·8; 5·9	8·42
Fowl's gall	57·5	8·3	3·5	5·0	10·99
Gall of various fresh-water fishes . . .	56·0; 55·4	8·1; 8·0	2·5; 2·4	5·6; 5·5	14·11

The following varieties of gall yielded the percentage of sulphur and ash given below:

	Ox gall.	Pig's gall.	Dog's gall.	Wolf's gall.	Fox gall.
Sulphur	3·8; 3·4	0·3—0·4	6·2	5·0	5·2
Ash	—	13·6—12·9	—	—	12·7

Taurin.—Redtenbacher(2) has found that when taurin is dissolved in potassa and carefully evaporated, it is decomposed into ammonia, which escapes, and sulphurous and acetic acids, which unite with the potassa. He therefore suggested that taurin is a combination of sulphurous acid with an organic substance; if the elements of sulphurous acid be subtracted from the formula of taurin, the formula of aldehyde-ammonia remains $C_4 H_7 N O_6 S_2 = S_2 O_4 + C_4 H_4 O_2, NH_3$. He considers the acetic acid to originate in the oxidation of the aldehyde contained in taurin, and looks upon the taurin as a bisulphite of aldehyde-ammonia in a condensed state, analogous to the condition of cyanate of ammonia in urea.—By passing sulphurous acid into an alcoholic solution of aldehyde-ammonia, Redtenbacher obtained a body forming white acicular crystals, which presented the exact composition of taurin $C_4 H_7 N O_6 S_2$. This substance is not however identical with taurin, but according to Redtenbacher it is bisulphite of aldehyde-ammonia; it is easily soluble in water, though it cannot be recovered from the solution by evaporation, as it remains behind as a gummy substance. It is soluble in spirit of wine but not in absolute alcohol. It changes slowly, when exposed to the atmosphere, more rapidly at

(1) Griffith has communicated an analysis of sheep's gall, according to which it contains, when dried at 100°, 60·1 per cent carbon, 8·9 hydrogen, 4·0 nitrogen, 20·3 oxygen, 6·3 soda, and 0·4 chloride of sodium; he says nothing of its containing sulphur (Phil. Mag. [3] XXXI, 366.

(2) An. Ch. Pharm. LXV, 37.

100°, when it becomes brown. If heated still farther it blackens, swells up, and leaves a spongy charcoal. When treated with acids and alkalies it is again broken up into aldehyde, sulphurous acid and ammonia. It is precipitated by salts of baryta, lead and silver; the white silver-precipitate contains a mere trace of organic matter. Taurin.

Biliary Calculi.—Bley(1) found that human biliary calculi contain for 96 parts of cholesterin, 4 of biliphæin, mucus of the gall-bladder, biliary colouring matter, phosphate of lime, and traces of the salt of an organic acid.

Hein(2) has examined biliary calculi and the biliary colouring matter. He determined the loss on drying, the amount of ash, the quantity of substances soluble in water, the amount of substances subsequently extracted by alcohol (cholesterin and saponifiable fat) and the quantity of residue, partly soluble, partly insoluble in boiling ammonia, in six different specimens of gall-stones of the absolute weight (in grms.) and spec. grav. stated.

	1.	2.	3.	4.	5.	6.
Absolute weight	11·74	9·15	9·46	12·61	4·95	10·77
Specific gravity	1·062	1·270	1·053	1·041	1·069	1·056
Constitution of 100 parts:						
Loss on drying	4·88	19·18	3·26	2·89	1·97	2·80
Ash	0·59	6·78	1·58	0·50	2·14	0·28
Substances soluble in water, and loss	8·21	10·14	5·01	7·56	3·79	10·47
Substance soluble in alcohol: Cholesterine	82·81	8·25	82·27	78·06	84·95	76·90
Substance soluble in alcohol: Saponifiable fat	1·50	2·70	1·11	4·27	2·30	7·51
Residue: Soluble in ammonia	0·46	1·11	0·70	0·52	0·13	0·83
Residue: Insoluble in ammonia	1·55	52·84	6·06	6·21	4·72	1·21

The ash contained chloride of sodium, carbonate of lime, and traces of iron; in a few cases there were also phosphates and traces of manganese, but never any copper.—Hein considered the residue left by the gall-stones after treatment with alcohol and water as biliary colouring matter; ammonia dissolved a portion of it, and the solution yielded, on the addition of hydrochloric acid, a green flocculent precipitate of Berzelius' biliverdin; the insoluble brown portion was looked upon as corresponding to cholepyrrhin. Hein arrived at results in reference to the composition of these two biliary pigments, which, when compared to one another were not found to

(1) Arch. Pharm. [2] XLIX, 271. (2) J. Pr. Chem. XL, 47.

Cholesterin. agree, nor did they do so with the results obtained by Scherer. We refer the reader to the treatise itself for the details.

Cholesterin.—Hein found the fusing-point of cholesterin to be from 169° to 170°, the spec. grav. of the fused cholesterin = 1:03.

Zwenger(1) has investigated the chemical constitution of cholesterin.—If cholesterin be added to a mixture of concentrated sulphuric acid with half its volume of water at from 50°—70°, and while the whole is stirred, sulphuric acid be dropped in until the cholesterin has lost its crystalline appearance, and has become soft, tenacious, and dark-red, three hydrocarbons are formed without evolution of gas.—If the white or yellow substance that has been washed with water be boiled with ether, an insoluble residue remains, *cholesterilin a*; alcohol precipitates a yellow, resinous mass, from the ethereal solution (undecomposed cholesterin remaining in solution), which is again dissolved in ether (*cholesterilin a* remaining undissolved); if this solution be slowly evaporated, *cholesterilin b* crystallizes first, and *cholesterilin c* is subsequently deposited as a resinous mass. Cholesterilin *a* crystallizes out of oil of turpentine in minute, fine, slightly shining, white needles, and is scarcely fusible without being decomposed (at about 240°); cholesterilin *b* crystallizes out of the hot ethereal solution in white brilliant plates, and fuses at about 255°; cholesterilin *c* cannot be obtained in the crystalline form, and fuses at 127°. Zwenger found that these three substances have very nearly the same composition; still he thinks it possible that they have various formulæ. We give the average of the analyses, and the calculation made according to the formulæ proposed by him, (it is not stated to which variety of cholesterilin the respective formulæ apply).

	a.	*b.*	*c.*	$C_{32}H_{26}$	$C_{32}H_{18}$	$C_{27}H_{22}$
Carbon	88·05	88·29	87·92	88·07	88·00	88·04
Hydrogen	12·09	12·18	11·99	11·93	12·00	11·96

Zwenger considers the composition of cholesterin to be $C_{81}H_{69}O_3$, and based upon this he explains the influence of the sulphuric acid, and the formation of these hydrocarbons by the equation $C_{81}H_{69}O_3 = C_{32}H_{26} + C_{22}H_{18} + C_{27}H_{22} + 3\,HO$.

Milk.—The composition of human milk has been examined by Griffith(2). In the following table A is the period after birth at which the milk was taken for the investigation, B its spec. grav.,

(1) Ann. Ch. Pharm. LXVI, 5. (2) Chem. Gaz. 1848, 192.

C the amount of solid residue (dried at 100°, in per cent of the milk), D the elementary composition, E the constituents of the residue. The food was of a mixed character, except in the second case where it was exclusively vegetal; the last is an analysis of the bluish milk of a scrophulous and phthisical woman :

A.	B.	C.	D.					E.		
			Carbon.	Hydrogen.	Nitrogen.	Oxygen.	Ash.	Butter	Sugar & Extractive.	Casein.
14 days	—	12·5	50·57	7·86	1·90	38·12	1·55	25·56	61·76	12·68
1 month	1·030	13·62	50·13	7·73	40·63		1·51	34·32	52·41	13·27
1 m. 14 d.	—	12·87	51·61	7·90	1·96	36·74	1·80	—	—	—
9 m. 6 d.	1·028	—	46·97	7·39	1·97	41·90	1·77	16·90	76·60	6·42
10 months	1·034	—	50·36	8·10	1·75	37·94	1·85	—	—	—
10½ months	—	—	43·31	7·80	46·98		1·91	—	—	—

Landerer(1) has analysed the milk of a woman treated with large doses of indigo, which became blue in the atmosphere; and he believes that it contained reduced indigo. Lepage(2) has examined rose-coloured milk, and ascribes the colour to an admixture of blood.

Dumas(3) had stated, that the milk of carnivorous animals when exclusively fed on meat contains no milk-sugar, whereas this is constantly present when the food is vegetal; Bensch(4), on the contrary, has shown that it is invariably present, and that it probably was not found, because when left for a length of time in contact with phosphate of lime and exposed to an elevated temperature it is converted into grape-sugar, and then remains as a syrup in combination with the extractive matters. Bensch found the following to be the composition of the (constantly acid) milk of two bitches A and B, which during the stated number of days had been fed exclusively on meat.

	Days.	Sp. gr.	Water.	Butter.	Milk-sugar and soluble salts.	Cheese and insoluble salts.
A.	8	1·036 at 20°	75·54	10·75	3·47	10·24
	12	1·037 „ „	70·39	—	—	—
B.	5	—	77·52	10·95	3·19	8·34

Milk of the bitch A after being fed on meat for twenty-six days yielded 1·252 per cent of ash; boiling water extracted 6·045 per cent of the ash ; the aqueous extract had an acid reaction, and con-

(1) Repert. Pharm. [2] XLV, 53.
(2) J. Chim. Méd. [3] III, 76.
(3) Instit. 1845, 341 ; Berzelius' Jahresber. XXVI, 909.
(4) Ann. Ch. Pharm. LXI, 221.

Saliva. tained potassa, traces of soda, lime, magnesia, besides phosphoric acid and chlorine, the residue contained chiefly phosphate of lime and phosphate of magnesia.

Saliva.—The following analyses of human saliva (A), and the saliva of the dog (B) are taken from a treatise by Jacubowitsch(1).

	A.	B.
Specific gravity	1·0023	1·0071
Water	995·16	989·63
Organic matter	1·34	3·58
Epithelium	1·62	—
Phosphoric acid	0·51	—
Phosphate of soda	0·43	0·82
Lime	0·03	—
Magnesia	0·01	—
Phosphate of lime and magnesia with organic matter	—	0·15
Chlorides of potassium and sodium	0·84	5·82
Sulphocyanide of potassium	0·06	

Urine.—We must limit ourselves to merely adverting to an investigation of Krahmer(2) "on the Physiological importance of Uropoiesis and the influence of Diuretics," in which a series of analyses of urine are given, which for the most part was passed under the influence of diuretics.

Carbonic Acid in the Urine.—The former statements of Proust, A. Vogel, Wöhler and others, with regard to the presence of carbonic acid in the urine of man have been confirmed by R. F. Marchand(3); he found on an average 10 cubic centimetres of carbonic acid in 100 grm. of urine at a spec. grav. of 1·012 to 1·017. Consumption of carbonated water does not perceptibly increase the amount of carbonic acid in the urine, as already noticed by Wöhler. Fresh milk exhibits a constant proportion, fresh ox-gall a trifling, but distinct amount, but fresh ascitic fluid none whatever.

Sulphur and Phosphorus in the Urine.—Ronalds(4) has made investigations into the condition in which sulphur and phosphorus exist in the urine, and has arrived at the conclusion that the entire amount of these substances is not contained in a state of oxidation. He first determined the amount of sulphuric and phosphoric acids in the urine by themselves, and then again after evaporating the same urine and heating with nitre; by the latter process he obtained a

(1) Dissertatio de Saliva. Dorpati, 1848.
(2) J. Pr. Chem. XLI, 1.
(3) J. Pr. Chem. XLIV, 250; Chem. Gaz. 1848, 480.
(4) Phil. Mag. [3] XXX, 253; J. Pr. Chem. XLI, 185.

Sulphur and phosphorus in the blood.

greater amount of both acids. He found the amount of sulphur contained in the urine, in a different form than sulphuric acid, to be from 0·015 to 0·018 for 100 parts of urine by weight; in a diabetic patient it amounted to 0·024. He estimates the quantity of this sulphur carried out of the body in the course of twenty-four hours by the urine, at 3·2 grms., and the quantity of phosphorus, not in the shape of phosphoric acid, quitting the body in the same manner and time, at 3·8 grms., or less; the latter point he promises to determine more accurately at a future period. He was unable to decide in what state of combination the sulphur, not forming sulphuric acid, exists in the urine; the precipitate formed with neutral, or basic acetate of lead, only contains traces of sulphur, as does the urinary colouring matter, when prepared according to Scherer's directions.

Urea in Urine.—Millon(1) states, that in the healthy urine of man there is a direct relation, if an accidental coincidence may be so termed, between the spec. grav. and the amount of urea, as the second and third numbers after the comma in the decimal of the spec. grav. (A), gives approximatively the amount of urea (B) contained in 1000 parts of urine.(2) In proof, he quotes the following determinations (the spec. grav. A is for 15°):

A.	1·0116	1·0046	1·0092	1·0277	1·0143	1·0110	1·0260	1·0290
B.	11·39	4·39	9·88	29·72	11·99	10·60	25·80	31·77

In animals the same relation does not occur; here he found:

	Rabbit.			Dog.		
A.	1·0092	1·0149	1·0160	1·052	1·054	1·050
B.	3·01	5·23	6·14	111·07	92·08	111·09

Nor is it the case in the urine of man when the mode of living is changed, or a disease is in existence; he found in:

	A.	B.
Pneumonia of right side, 2nd stage	1·015	39·75
Pneumonia of right side, 2nd stage	1·025	45·94
Articular rheumatism	1·028	43·11
Pneumonia of both sides	1·017	42 90
Pneumonia of both sides	1·024	39·40
Phthisis, third stage	1·043	24·25
Diabetes	1·037	8·25
Diabetes, with febrile action	1·039	21·50
Diabetes	1·035	5·51

(1) Compt. Rend. XXVI, 120.

(2) It would have been important to determine the relation between spec. grav. and composition in a pure solution of urea.

Absence of lactic acid in urine.

Absence of Lactic Acid in Urine.—Liebig(1) was unable to discover lactic acid in the urine, whether fresh or putrid, nor when passed after a consumption of lactate of potassa (before this was taken the urine was strongly acid, afterwards strongly alkaline; in the latter case, a larger amount of potassa was observed in it than it generally contains.

Creatin and Creatinine in the Urine.—Heintz(2), in 1844, described an elaborate method for obtaining the zinc-salt of a new acid contained in the urine. He stated that if this substance was separated from the zinc-compound, in an aqueous solution, by sulphuretted hydrogen, it proved to be a crystallizable, easily soluble acid, whose deportment, with several substances, he described.—Pettenkofer(3) found, at the same time, that when a concentrated alcoholic solution of chloride of zinc was added to the alcoholic extract of the residue of urine, which had been neutralized with carbonate of soda, and carefully evaporated, a crystalline combination is deposited, which contains, together with chloride of zinc, an organic substance; for the latter his analysis corresponded to the formula $C_8 H_8 N_3 O_3$.

Liebig showed that this combination of chloride of zinc is obtained more easily by neutralizing the urine with a little milk of lime, and adding a solution of chloride of calcium, so long as phosphate of lime is separated, then filtering, evaporating until the salts have crystallized, and adding to the mother-liquor a syrupy solution of chloride of zinc; the chloride of zinc compound then separates, after a few days, in the shape of crystals. If the chloride of zinc compound be washed with water, dissolved in boiling water, and boiled with hydrated protoxide of lead, until a strongly alkaline reaction ensues, the organic substance contained in that compound remains in solution, and may (after purification with a little animal charcoal) be obtained crystallized by evaporation. According to Liebig, the substance thus obtained is a mixture; the portion that is less soluble in boiling alcohol is creatin (dried, $C_8 H_9 N_3 O_4$), the less soluble portion is creatinine ($C_8 H_7 N_3 O_2$); Pettenkofer examined a mixture of both, which completely accounts for the analytical results obtained by him. From putrid urine, creatinine only is obtained, which, after the urine has been boiled with milk of lime until

(1) Loc. cit. II, p. 161.
(2) Pogg. Ann. LXII, 602; Berzelius' Jahresber. XXV, 899.
(3) Ann. Ch. Pharm. LII, 97; Berzelius' Jahresber. XXV, 900.
(4) Loc. cit. II, p. 161 (Ann. Ch. Pharm. LXII, 303); J. Pr. Chem. XL, 288.

Creatin and creatinine in the urine.

no more ammonia is evolved, is deposited on evaporation of the filtrate to a syrup, and addition of chloride of zinc, in combination with the latter; it is free from creatin.—Liebig considers creatin as an accidental and variable admixture of the chloride of zinc compound.

Heintz(1) stated that the substance (comp. II. p. 198) which he viewed as a new acid, owed its acid character merely to its containing hydrochloric acid, and that its alleged zinc-salt was identical with Pettenkofer's chloride of zinc compound(2). He does not mention that the relation of 8 C to 3 N, found by Pettenkofer in the chloride of zinc combination, points to creatin. He found the composition of the organic substance, separated from it by ammonia and sulphide of ammonium, to correspond with that of creatin; his analysis of the chloride of zinc compound (comp. II. p. 166), however, shows that it contains creatinine. He has since communicated investigations(3), which account for this appearance of creatin. According to them, creatinine may be converted into creatin. The change is effected in the best way, but still always imperfectly, if the creatinine be combined with chloride of zinc, and the organic matter in solution be again in some manner separated. If the creatinine be set free from its combinations with hydrochloric acid, or sulphuric acid, creatin is formed also, but only in minute quantities. It appears that the more creatin is produced from the chloride of zinc combination, the more the solution is diluted before the organic substance is liberated. The chloride of zinc precipitate, obtained from the urine, contains no creatin in the first instance, but this may be prepared from it. The simplest method for obtaining the largest amount of creatin from the urine, consists in decomposing the dilute solution of the chloride of zinc combination, precipitated from it, with ammonia and sulphide of ammonium, and separating the creatin from the filtered fluid by evaporation, and the addition of alcohol; the

(1) Pogg. Ann. LXX, 466.

(2) It is possible and even probable that Heintz has been over-hasty in recalling his former statements, and in converting the discovery of an acid into that of an alkaline base (creatinine), or an indifferent substance (creatin). According to the description given by Heintz, the acid discovered by him is easily soluble in water (creatin is difficultly soluble), the solution strongly reddens litmus (creatinine has an alkaline reaction), and has an acid taste; alcohol also dissolves it (creatin is insoluble in alcohol). Heintz obtained no precipitate by nitrate of silver. He believes that in the evaporation of the hydrochloric acid solution of the creatinine, all the hydrochloric acid was dissipated, and that this prevented his obtaining a precipitate with nitrate of silver in the solution of the residue (hydrochlorate of creatinine does not lose its hydrochloric acid, when evaporated).

(3) Pogg. Ann. LXXIV, 125; Ann. Ch. Pharm. LXVIII, 361.

Creatin and creatinine in the urine.

chloride of zinc precipitate, obtained from the residuary mother-liquor, is again separated into creatin, and an alcoholic mother-liquor, by means of ammonia and sulphide of ammonium; this operation is repeated until it no longer appears worth while to renew it. For the purpose of obtaining creatinine, the only useful method is the one given by Liebig (comp. II. p. 198). In normal urine creatin must not be supposed to pre-exist, as in the experiments which seemed to prove its presence, it had been formed from the creatinine present. Heintz's experiments have also failed in directly demonstrating its presence in the urine. The conversion of creatinine into creatin, when separated from its combinations, renders the method of determining its quantity, which is based upon the insolubility of its chloride of zinc compound, when united to an acid, so unsafe, that as yet, the proof cannot be given that muscular contraction is the cause of the formation of these substances.

On the Transition of various Substances into the Urine.—Wöhler and Frerichs(1) have instituted extensive researches, chiefly on dogs, as to the changes which various, and especially organic substances, suffer by their transition into the urine. *Salicylous acid* does not operate as a poison; unchanged salicylous acid was found in the urine, but neither salicylic, nor hippuric acid. *Oil of bitter-almonds,* deprived of its hydrocyanic acid, did not operate as a poison; hippuric acid was discovered in the urine. *Amygdalin* was not poisonous (in small doses); neither amygdalin, nor hippuric acid, were traceable in the urine. *Benzoic ether* intoxicated; no benzoic ether was discovered in the urine, but hippuric acid presented itself. *Peruvian balsam,* by its amount of cinnamic acid, caused the formation of hippuric acid; when heated with hydrochloric acid, the urine assumed a blood-red colour. *Tannic acid* was traced in the urine as gallic and pyrogallic acids. *Urates* yielded oxalic acid and urea. *Allantoin* neither caused oxalic acid, nor could it be traced itself. *Sulphocyanide of potassium* (not poisonous), when given even in minute doses, was invariably traceable in the urine. *Thiosinnamine* (not poisonous) invariably caused sulphocyanide of ammonium in the urine. The changes of *kinone* (not poisonous) could not be discovered, nor could those of *aniline.* *Carbolic acid* was powerfully poisonous; *alloxantin* was not traceable in the urine, but the latter exhibited a large amount of urea after its administration. The presence of *alloxan* could not be traced; *urea* was not converted into

(1) Ann. Ch. Pharm. LXV, 335; J. Pr. Chem. XLIV, 60; Repert. Pharm. [3] I, 219; Instit. 1848, 145; Chem. Gaz. 1848, 229.

carbonate of ammonia, the urine remaining acid. The effect produced by arsenic, arseniate of lime (3 CaO, AsO_5), and phosphoric acid, was investigated, but the results are out of place here. Urine in disease.

Schlossberger(1) is of opinion that the peculiar colour of the urine after the employment of rhubarb is mainly caused by the two uncrystallizable pigments of rhubarb.

Urine in Disease.—Preisser(2) and Chevallier(3) have communicated observations of the appearance of sperm in the urine; Semmola(4) on blue urine, which was caused by an amorphous deposit of a non-nitrogenous colouring matter, which is insoluble in water, alcohol, and acids, and slowly soluble in ether. Semmola designates this colouring matter as *cyanurin*, although it presented a deportment different from that of the substance thus termed by Bracconnot(5).

Bence Jones(6) found a new, albuminous substance in the urine of a man suffering from mollities ossium, which was precipitable by alcohol from the urine; it was soluble in water, but in this solution it only coagulated after continued ebullition, and was redissolved after still longer boiling, if the water which evaporated was replaced; it was soluble in potassa, and was precipitated from this solution by excess of acetic acid; the aqueous solution yielded a precipitate with nitric acid, which disappeared on heating, and was formed again on cooling; the aqueous solution yielded, after the addition of acetic acid, a white precipitate with ferrocyanide of potassium, soluble in potassa; the aqueous solution gave precipitates with sulphate of copper and protochloride of mercury, which dissolved on the addition of acetic acid. This substance, when treated with ether and dried *in vacuo* over sulphuric acid, yielded on analysis, 51·5 to 52·3 of carbon, 7·0 to 7·2 of hydrogen, 14·8 to 15·2 of nitrogen, 1·0 to 1·4 of sulphur, and 0·2 of phosphorus. Filtered urine of the patient, of a sp. gr. 1·0396, exhibited the composition given in the following table, under A. (p. 203).

Fonberg(7) has examined the fermentation of diabetic urine. Variation of temperature merely alters the duration of the fermentation; so that the fermentation of 15 litres of urine at 15° is termi-

(1) Ann. Ch. Pharm. LXVI, 83.
(2) J. Pharm. [3] XIII, 339; J. Chim. Méd. [3] IV, 477.
(3) J. Chim. Méd. [3] IV, 478.
(4) Ibid. [3] 419; Repert. Pharm. [2] XLVIII, 180.
(5) Ann. Ch. Phys. [2] XXIX, 252.
(6) Phil. Trans., Part I, 1848; Ann. Ch. Pharm. LXVII, 97.
(7) Ann. Ch. Pharm. LXIII, 360.

Urine in disease.

nated in four weeks, at from 30 at 35° in from five to six weeks. The fermentation proceeds equally in the atmosphere and in a space confined over mercury, but in the first instance putrefaction ensues. It occurs spontaneously with the same facility as on the addition of yeast, and with the same phenomena; the urine becomes opaque, whitish, and a quantity of transparent globules become perceptible under the microscope, which are insoluble in alcohol, ether, dilute acids, and alkalis; the gases evolved during fermentation, exceed in bulk that of the urine employed, and consist of hydrogen and carbonic acid, at first in the proportion of 1 to 2 and 2½ (irrespective of the gas absorbed by the fluid), and subsequently of 1 to ¾ and ½. The fermented liquor has an acid reaction; it no longer contains urea, but weakly acid ammonia-salts, and especially butyrate of ammonia. By boiling the fresh urine and repeating the ebullition at intervals of from three to four days, the fluid could be preserved for more than a month in the unfermented state, at from 15°—20°. The less urine a patient passed in twenty-four hours, the greater was the amount of urea; when from 9 to 10 litres were passed, 1·8 to 2·0 grms., when 2½ litres were evacuated, 7 grms. of nitrate of urea were obtained from 1 litre of urine. In 1 litre of urine, of spec. grav. 1·0231, 46·5 grms., in another of 1·008, 32 grms. of urea were found. Fonberg also found sugar in the venous blood of a patient, 0·025 in 72·7 grm. An analysis of diabetic urine (sp. gr. 1·032) by Reich, in Königsberg(1) is given under B. in the following table.

Urine of the Calf and the Ram.—Braconnot(2) has examined the urine of a calf 8 days old (C.) and of a sheep (D.); the former was

	A. p. 201.	B.	C.	D. in 1 litre.
Uric acid	0·96	1·31	—	—
New body	66·97	—	—	—
Sugar	—	43·30	—	—
Urea	29·90	9·70	2·36	not determined.
Extractive matter		20·58		
Mucus	—	0·28	traces	ditto.
Chloride of sodium	3·83	0·82	?	—
Chloride of potassium	—	0·27	3·22	6·13
Phosphate of soda	5·45	1·75	—	—
„ lime	1·20	0·33	traces	—
„ magnesia		0·02	—	—
„ magnesia-ammonia	—	—	0·18	—
Sulphate of potassa	2·10	0·25	0·44	3·74
Silicic acid	—	0·03	traces	—
Carbonate of magnesia	—	—	—	1·40
Water	890·72	921·36	993·80	—

(1) Arch. Pharm. [2] LI, 20.

(2) Ann. Ch. Phys. [3] XX, 238; J. Pr. Chem. XLI, 301.

Urinary calculi.

also found to contain traces of phosphate of iron and potassa, and of a potassa-salt with an organic acid; in the latter were found undetermined quantities of hippurate and bicarbonate of potassa, carbonate of lime and sesquioxide of iron.

Urinary Calculi.—The calculi examined were: (A. in the following table) calculi taken from a man by Bley(1) and (B and C) by Reich(2) in Königsberg; a calculus taken from the urethra of an ox (D) by Lassaigne(3); a urinary calculus from a bitch by Wittstein(4), who found in it 27·82 per cent of lime, 5·22 of magnesia, 3·90 of ammonia, 24·21 of phosphoric acid, 10·64 of carbonic acid, 8·93 of soda-salts, 5·15 of nitrogenous matter, 14·13 water; a urinary calculus from a monkey (E.) by Landerer(5); urinary calculi from sheep, with whose food oats had been mixed (F.), by Lassaigne(6); one from a tortoise (*Testudo polyphemus*), by the same(7), (in which he found 72·4 per cent of uric acid, 13·0 of ammonia, 1·0 of lime, 13·6 of urinary constituents soluble in water, and alkaline salts).

	A.	B.	C.	D.	E.	F.
Extractive or colouring matter	—	8·93	0·12	—	—	—
Albumin	7·50	—	—	—	—	—
Fat	5·00	0·33	0·34	—	} 16	—
Mucus	traces	0·46	0·28	} 10·7		53·0
Water	—	—	—		—	12·0
Oxalate of lime	12·50	—	11·82	—	—	—
Phosphate of lime	22·21	—	1·58	traces	73	—
„ magnesia	12·27	—	—	—	5	—
„ magnesia-ammonia	—	—	0·64	—	—	34·2
Uric acid	—	58·45	—	—	—	—
Urate of ammonia	—	31·83	3·45	—	—	—
„ soda	—	—	1·14	—	—	—
Carbonate of lime	35·52	—	80·63	87·8	6	0·8
„ magnesia	—	—	—	1·5	—	—
Loss	5·00	—	—	—	—	—

Gout-Stones.—Th. J. Herapath(8) found the gout-stones taken from the finger-joints of a man to contain 1·12 per cent of fat, 43·97 of urate of soda, with a little urate of potassa, 14·77 of urate of lime, 34·14 of phosphate of lime, 5·99 of water (and loss), traces of phos-

(1) Arch. Pharm. [2] XLIX, 257.
(2) Ibid. [2] LIII, 297.
(3) Ann. Ch. Phys. [3] XIX, 382; J. Chim. Méd. [3] III, 10.
(4) Repert. Pharm. [3] I, 307.
(5) Ibid. [2] XLV, 60.
(6) J. Chim. Méd. [3] III, 322.
(7) Ibid. [3] IV, 480.
(8) Chem. Gaz. 1848, 383.

Gout-stones.

phate of iron and soda, chloride of sodium, extractive matter and albumin.

Landerer(1) found a concretion from the aorta of a person who had died in consequence of pericarditis from arthritic metastasis, to consist of 14 uric acid, 6 animal matter, 6·2 phosphate of lime, 16 carbonate of lime, and 2 carbonate of magnesia.

Renal Calculus.—Venghauss(2) has made a communication on the renal calculus of a man, which he considers to be composed of cystine, with scarcely perceptible traces of albumin, and a resinous substance; he found, however, only 15·2 per cent of sulphur, whilst, according to Baudrimont and Thaulow's analyses, cystine contains 26 per cent.

Excrements.—J. R. Rogers(3) has investigated the composition of the excrements of pigs (A.), cows (B.), sheep (C.), and horses (D.), Vohl those of dogs (*Album græcum*) (E.); 100 parts of the latter, dried at 100°, yielded to water 4·86 of a brown extract-like substance, the solution of which assumed a reddish-brown colour on the addition of tincture of iodine. Vohl (and Rogers) has also separately examined that part of the excrements (or the ash) which is soluble in water (or in water and hydrochloric acid) and the insoluble portion. We shall here only give the composition of the ash (under E. of the excrements) in toto.

	A.	B.	C.	D.	E.
100 excrement (fresh) contain water	77·13	82·45	56·47	77·25	
100 ditto, dried at 100°, yield ash	37·17	15·23	13·49	13·36	
100 ash contain sol. in water	9·65	5·84	17·29	3·16	
„ „ „ „ in hydrochl. acid	18·70	32·21	—	22·59	
„ „ „ „ in nitric acid	—	—	34·54	—	
„ „ „ insoluble	71·65	61·95	48·17	74·25	
			Composition of the entire ash:		
Potassa	3·60	2·91	8·32	11·30	0·30
Soda	3·44	0·98	3·28	1·98	0·44
Lime	2·03	5·71	18·15	4·63	33·05
Magnesia	2·24	11·47	5·45	3·84	0·09
Proto-scsquioxide of manganese	—	—	traces	2·13	—
Chloride of sodium	0·89	0·23	0·14	0·03	—
Phosphate of sesquioxide of iron	10·55	8·93	3·98	2·73	—
Phosphoric acid	0·41	4·76	7·52	8·93	34·46
Sulphuric acid	0·90	1·77	2·69	1·83	—
Carbonic acid	0·60	—	traces	—	7·46
Chlorine	—	—	—	—	0·04
Silicic acid	13·19	62·54	50·11	62·40	traces
Sand	61·37				—
Iron and loss	—	—	—	—	0·01
Organic constituents	—	—	—	—	14·15

(1) Repert. Pharm. [2] XLV, 60.
(2) Arch. Pharm. [2] XLIX, 38.
(3) Ann. Ch. Pharm. LXV, 85.
(4) Ibid. 266.

Excrements.

J. Davy(1) stated that the excrements of spiders contained a substance possessing all the properties of so-called xanthic oxide which Unger formerly considered identical with the substance found by him in guano, and subsequently termed guanine. Fr. Will and Gorup-Besanez(2) have now found that the excrements of the cross-spider (*Epeiva diadema*) contain guanine; they consider it probable that guanine is also contained in the so-called green organ of the fresh-water craw-fish (*Astacus fluviatilis*) and in Bojanus's organ in the fresh-water muscle (*Anodonta*).

Examination of an Osteosarcoma.—Roux(3) found an osteosarcoma, taken from the upper part of the humerus, to be composed of 87·86 per cent of water, 9·85 of chondrinoid cartilage, 0·30 of albumin, 0 28 of fat, 0·67 of carbonate of lime, 0·59 of phosphate of lime, 0·21 of sulphate of soda and potassa, 0·14 of carbonate of soda, 0·10 of chloride of sodium and potassium, traces of silicic acid, phosphate of magnesia, alumina and sesquioxide of iron.

Feathers. Silicic Acid contained therein.—Gorup-Besanez(4) has instituted numerous experiments on the amount of silicic acid contained in the feathers of various birds, from which it appears indubitable that those birds whose food is richer in silicic acid, and which therefore live upon seeds and corn, assimilate more silicic acid in their feathers, and generally more inorganic materials than those which live upon meat, insects, or berries. The averages of a great number of determinations are:

Birds living upon:	Their feathers contain in 100 parts:		
	Ash.	Silicic acid.	100 ash contain silicic acid.
Seeds	4·84	1·98	40
Fish	2·41	0·23	10·5
Flesh . , . . .	2·16	0·64	27
Insects, berries . . .	2·62	0·75	27

The age of the animal, as well as the feathers themselves and the species of the latter, influence the amount of silicic acid; the feathers of the older animals contain more than those of the younger animals; in the same way, the pinions contain more than the feathers of the tail and belly.

No silicic acid was traceable in the egg.

(1) Edinb. new Phil. Journ. XL, 231, 335; Berzelius' Jahresber. XXVII, 681.

(2) Anz. d. Bair. d. Wissensch. (No. 233) 1848, 825; Ann. Ch. Pharm. LXIX, 117; J. Pr. Chem. XLVI, 153.

(3) J. Pharm. [3] XI, 429.

(4) Ann. Ch. Pharm. LXI, 46; LXVI, 321.

Feathers. Silicic acid contained therein.

The hair of various animals, as well as of man, yields on an average 2·6 per cent of ash, containing 10·8 per cent of silicic acid.

According to Henneberg(1), the amount of silicic acid contained in about 80 grms. of a fowl's feathers is about 0·200 grm., the wing- and tail-feathers contain 0·14 per cent (17·1 of the ash), the feathers of the breast and belly 0·29 (29·0) of silicic acid.

Tortoiseshell.—We quote the following remarks from an investigation of A. Völcker(2) on tortoiseshell (of *Testudo tabulata*). The white parts, cut up and successively exhausted with cold water, spirits of wine and ether, and dried at 100°, yielded from 0·23 to 0·27 of ash; the dark parts, similarly treated, 0·24 to 0·35 per cent of a darker ash, richer in iron, and containing chloride of sodium, sulphate of magnesia, carbonate of lime, carbonate of magnesia, phosphate of lime, sesquioxide of iron and silicic acid. In the shell of the marine and terrestrial tortoise thus purified, there were found (calculated for substance free from ash) from 53·8 to 54·2 per cent of carbon, 6·4 to 6·5 of hydrogen, 14·8 of nitrogen, 21·5 to 22·9 of oxygen, 1·9 to 3·2 of sulphur; according to which, its composition differs from that of horn. For the products of the action of various reagents and for the numerous elementary analyses of these substances, we refer to the treatise, as they do not present any definite chemical combinations.

Silk-Juice.—H. Ludwig(3) has examined the silk-juice which the silk-worm discharges when forming the cocoon, and which in the atmosphere immediately hardens into silk. The amber- and gold-coloured, transparent, tough juice dissolves in water, and imparts to it a golden colour; the solution when boiled, foams, but without in the least coagulating; it is neutral. After thirty-six hours, the aqueous solution of the silk-juice forms a tremulous jelly, which is no longer completely soluble, even when boiled in an increased quantity of water. A drop of the hot solution, taken out with a glass rod, congeals partly while dropping, into a silk thread, to which the remainder of the drop remains attached. If a drop of a dilute acid be added to a fresh aqueous solution of silk-juice, the silk separates as a flocculent coagulum, which does not redissolve in the cold in an excess of acid; if much acid be added, the solution remains clear, but after a few hours, congeals into a jelly. The silk-juice, when boiled with concentrated hydrochloric acid, assumes a dingy-violet colour; it is not precipitated by ferrocyanide of potassium, protochloride of

(1) Ann. Ch. Pharm. LXI, 261.
(2) From the Authors Inaugural dissertation in Pharm. Centr. 1847, 577.
(3) Arch. Pharm. [2] LIV, 142; Ann. Ch. Pharm. LXVIII, 366.

mercury, lime-water, and nitrate of silver; tannic acid causes a viscid flocculent precipitate; acetate of lead and sulphate of copper, a gelatinous coagulum; caustic soda does not change the solution; if a little sulphate of copper be added, some copper remains in solution, and a violet colour is formed. The silk-juice, when boiled with caustic soda, evolves no sulphuretted hydrogen on the addition of hydrochloric acid. Silk-juice.

Spongia Marina.—Vogel, Jun.(1) has stated that sponge (*Spongia marina*) contains the iodine chiefly in an insoluble combination, as water only extracts a trace of iodide of sodium; by exhausting with water the sponge loses 12 per cent of its weight (chloride of sodium, sulphate of magnesia, carbonate of magnesia, and organic matter; there being no lime in the extract); sponge that has been purified and long treated with water yields 16 per cent, unpurified sponge 22 per cent of ash; when the sponge is incinerated, a little iodine escapes. A new analysis of the officinal sponge-ash has been made by Heyl(2); he failed in detecting copper and bromine as his predecessors had done. He found its constituents to be:

Carbon	10·47
Cyanogen, calculated from the nitrogen found	3·27
Iodide of magnesium	0·24
Chloride of potassium	0·16
Chloride of sodium	6·15
Chloride of calcium	0·47
Sulphate of lime	8·88
Carbonate of lime	27·37
Phosphate of lime	1·88
Protoxide of iron	6·85
Silicate of alumina	29·18
Sand	4·01
	98·93

(1) Repert. Pharm. [3] II, 118.
(2) Ann. Ch. Pharm. LXII, 87; Repert. Pharm. [2] XLVII, 231.

ANALYTICAL CHEMISTRY.

Application of chloride of ammonium in chemical analysis.

Application of Chloride of Ammonium in Chemical Analysis.—H. Rose(1) has amply investigated the behaviour of chloride of ammonium, at a red heat, towards many oxides and salts, and has pointed out that this behaviour admits of manifold applications in quantitative researches.

Arsenic, antimony, and *tin,* when combined with alkalies in the form of salts, are completely volatilized, if a mixture of the finely-powdered salt with five or eight times its weight of chloride of ammonium, be ignited in a covered porcelain crucible until the weight is constant. From the weight of the residual chloride, which is not heated to fusion, the composition of the salt may be calculated. By this method H. Rose has analysed with sufficient accuracy the combinations of the acids of arsenic, antimony, and tin with the alkalies. Schlippe's salt, likewise, when ignited with sal-ammoniac, leaves a residue of chloride of sodium, whilst, if fused alone, or in a stream of hydrogen or carbonic acid, it parts merely with the water which it contains.—*Arsenite of lime* is decomposed with difficulty by sal-ammoniac at a red heat; *arsenite of magnesia* undergoes no decomposition: the latter, however, when heated with sulphate of ammonia, yields a residue free from arsenic.

Titanic acid suffers no diminution of weight by ignition with sal-ammoniac; if it be combined with the alkalies, the latter are converted by this process into chlorides; from the increase of weight, therefore, the composition of the dry salt may be calculated. To control this determination, the mass remaining after ignition with sal-ammoniac is exhausted with water, filtered from the undissolved titanic acid,

(1) Pogg. Ann. LXXIII, 582; LXXIV, 562; J. Pr. Chem. XLIV, 117; XLV, 114; Berl. Acad. Ber. May, 1848; Instit. 1848, 226, 377.

Application of chloride of ammonium in chemical analysis.

and the amount of the chloride determined by evaporation. In hydrated salts the water is previously determined by ignition. H. Rose communicates the fact, that according to Weber's analysis, the acid titanate of potassa, dried at 100°, has the formula: $KO, 6\,TiO_2 + 3\,HO$, and the acid titanate of soda, $2\,NaO, 9\,TiO_2 + 5\,HO$. The former is a hard crystalline powder; the latter forms an uncrystallizable vitreous mass.

The *alkaline phosphates*, when ignited with sal-ammoniac, are entirely converted into chlorides; *sulphate of baryta* suffers only a partial conversion; *sulphate of magnesia* undergoes no decomposition. *Seleniate of baryta* leaves a mixture of selenite of baryta with chloride of barium, possessing a brown colour, due to free selenium.

When *alumina* and *sulphate of alumina* are ignited with sal-ammoniac, the former is, to a great extent, the latter entirely, volatilized; *potassa-alum* leaves a double chloride of potassium and aluminum, which is volatilized only with difficulty. *Berylla* comports itself in a similar manner. *Sesquioxide of iron* is partly volatilized as chloride, which deposits sesquioxide of iron in a crystalline state, on the sides of the crucible. The *oxides of manganese* are converted into a mixture of protochloride and proto-sesquioxide of manganese; the *protoxides of nickel* and *cobalt* yield the reguline metals, as also does *teroxide of bismuth*; *arsenide of nickel* leaves a residue of protochloride of nickel; *protochloride of silver* remains unchanged; *protoxide of silver* yields protochloride and metallic silver; *antimonide of silver*, $Ag_2\,Sb$, is only partly decomposed.—*Protoxides of zinc* and of *lead*, as also *sulphate of protoxide of zinc* and *sulphide of lead*, are difficultly, but with access of air completely volatilized as chlorides. *Sesquioxide of chromium* undergoes no change; the *chromates of the alkalies* leave sesquioxide of chromium and chlorides of the metals; *nitrate of sesquioxide of uranium* gives proto-sesquioxide of uranium; *silicic acid* suffers no diminution of weight, if by continuous ignition it has acquired some degree of density; *phosphate of soda* is partly decomposed into chloride of sodium and some chloride of phosphorus; *borax* remains unaltered; *fluorides of sodium* and of *calcium* are difficultly, *bromide of sodium* and *iodide of potassium* partly, decomposed with production of their respective chlorides.

Analysis of Gases.—Doyère(1), Regnault and Reiset(2) have brought forward proposals for an apparatus for the more accurate

(1) Compt. Rend. XXV, 928.

(2) Ibid. XXVI, 6; J. Pr. Chem. XLIII 168. An accurate description of the apparatus and the methods for the analysis of different gaseous mixtures was published only in 1849 (Ann. Ch. Phys. [3] XXVI, 329).

Analysis of gases.

analysis of gases. The two latter have claimed the priority with regard to the principle upon which the new methods are based, namely to employ different spaces for exposing the gases to the various chemical reactions and for measuring them.(1) Bunsen's apparatus and methods for the analysis of gaseous mixtures have been synoptically arranged and described by Kolbe(2).

Oxygen.—Brunner(3) recommends for the determination of the oxygen in the atmosphere, to mix a salt of sesquioxide of iron and a salt of alumina in such proportions, that the precipitate produced by ammonia may contain about 96 parts of sesquioxide of iron to 4 of alumina, to wash the precipitate, to dry it carefully, and to expose it to the reducing action of dry hydrogen at a temperature somewhat below redness; a known volume of dry air, contained in an aspirator, is then allowed to pass over the mixture thus obtained (which is pyrophoric, on account of the minute division of the iron by means of the alumina), and the increase of weight (*i. e.*, the amount of oxygen contained in the air employed for the experiment) determined. Less accurate, but according to his experience, equal to the older eudiometrical methods, is the following process; an appropriate quantity of a concentrated solution of sulphate of protoxide of iron, is introduced into a graduated glass tube, closed at one end, and covered with a layer of a dilute solution of potassa; the volume of the air contained in the tube is read off, the latter closed, and agitated violently for several minutes; it is then opened under water, and the volume of the remaining nitrogen gas ascertained; this method is stated to be also adapted for the preparation of larger quantities of nitrogen.

Hydrogen.—Laurent(4) has, incidentally to his analysis of several

(1) Compt. Rend. XXV, 960; comp. Compt. Rend. XXVI, 2.

(2) Liebig, Poggendorff und Wöhler's Handwörterbuch der Chemie, II, 1051.—We will here farther adduce some apparatus which have found no place in the preceding pages. Hare (Sill. Am. J. [2] IV, 37; Phil. Mag. [3] XXXI, 355) has described an oxy-hydrogen blow-pipe, for fusing larger quantities of rhodium, iridium, osmium and platinum; Schulze (J. Pr. Chem. XLIII, 368) a blow-pipe apparatus. Proposals for farther improvements of the still have been made by Maumené (Ann. Ch. Phys. [3] XXI, 127); of a syphon which serves to draw off corrosive liquids, and for the connection of Woulfe's bottles by Taupenot (Ann. Ch. Phys [3] XXI, 503); of a gas-holder by Wallmark (Pogg. Ann. LXXII, 185); for the closing of glass-vessels with large apertures, and for an easily arranged contrivance for cupellation by Th. Taylor (Phil. Mag. [3] XXXI, 393; Chem. Soc. Mem. III, 315); for the construction of a bath for different temperatures by Evans (Pharm. J. Trans. VIII, 38).

(3) Pogg. Ann. Ergänzungsb. II, 509.

(4) Ann. Ch. Phys. [3] XIX, 360; Ann. Ch. Pharm. LXII, 96; J. Pr. Chem. XL, 400.

organic bases, made use of the following process, which he asserts, allows to determine the hydrogen within $\frac{1}{1000}$.—The substance, which need not be powdered, is coarsely mixed in the combustion-tube with some hot oxide of copper, the whole being then covered with oxide, at a temperature of between 200° and 250°, and the combustion of the carbon completed by means of oxygen gas. This is evolved from a tube of about 30 to 40 centimetres in length, containing 3 or 4 grms. of fused chlorate of potassa, and connected with an U-shaped tube, whose first limb is filled with sticks of caustic potassa, while the second contains chloride of calcium. The first limb of this tube communicates with a safety-tube drawn out to a point which, after the combustion, when the reduced copper has ceased to absorb oxygen, is broken off, when air is drawn through the apparatus in the usual manner. The oxygen-apparatus is connected by means of a caoutchouc joint with the combustion-tube, only after the combustion is finished, when, a little air having been sucked out of the apparatus in order to diminish the pressure within the tube, the extremity of the beak is broken off, and the latter inserted into the caoutchouc connector. Hydrogen.

Carbon.—Städeler(1) found that oxygen-gas, perfectly dry and free from carbonic acid, as it is employed to effect the complete combustion of organic substances rich in carbon, is not absorbed, even when passed for a very long time through a solution of potassa of spec. grav. 1·3, a result which contradicts the opinion, based upon H. Rose's experiments, of errors being caused by an absorption of this kind in carbon-determinations.

Determination of Carbon in Graphite.—R. E. Rogers and W. M. Rogers(2) recommend the following process for the quantitative determination of carbon in graphite; the substance is triturated with about thirty times its weight of quartz-sand to an impalpable powder, and introduced into a tubulated retort with a mixture of chromate of potassa and sulphuric acid (1 vol. of water and 5 vols. of concentrated acid). The carbonic acid which is evolved upon the application of heat, is conducted, first, into an upright cylinder, kept cool (in order to condense the sulphuric acid which may have been carried over), then dried by means of chloride of calcium, and finally collected in a weighed potassa-apparatus. The oxidation is entirely completed in from thirty to forty minutes, but only if the graphite has been finely divided, so that minute scales are no longer perceptible.

(1) Ann. Ch. Pharm. LXI, 113. (2) Sill. Am. J. [2] V, 352.

Determination of carbon in cast-iron.

Determination of Carbon in Cast-Iron.—Kudernatsch(1) prefers the employment of protoxide of copper to that of chromate of lead for the determination of carbon in cast-iron.

Carbonic Acid.—H. Vohl(2) has described a modification of the apparatus proposed by Will and Fresenius for the determination of carbonic acid: if a substance, in which the carbonic acid is to be determined by the aid of this apparatus, disengages at the same time hydrochloric or hydrosulphuric acid gas, he prevents the escape of these latter by the appropriate intervention of protoxide of mercury. In cases in which the volume of the evolved carbonic acid gas is to be determined, Vohl introduces the powdered substance into a tube, which is drawn out to a point at one extremity, and is somewhat contracted at the other; he then fills the tube with water and allows it to pass through mercury into a graduated jar. Upon the introduction of the acid, the carbonic acid is evolved, whilst its volume is not increased by air simultaneously introduced.

Determination of Carbonic Acid in Urine, Milk, &c.—R. F. Marchand(3) determines the carbonic acid in urine by the following simple process. The urine is introduced into a glass flask, which is closed air-tight by a cork twice perforated; through one of the openings passes a tube, which dips into the urine, and is drawn out at the other extremity to a fine point, which may be easily sealed; through the second aperture passes a tube, bent twice at right angles, which is conducted through an air-tight cork into an empty flask; from this flask passes, through the same cork, a second tube which leads into a flask similar to the foregoing, filled with baryta-water (which is better adapted for this purpose than lime-water) and communicating with a second and third flask, likewise containing baryta-water; the last flask is in connection with an air-pump. When the apparatus is air-tight, the urine is heated in a water-bath to a temperature of about 50^0 or 60^0, and the air-pump gently put in motion. The liquid soon enters into ebullition, distils over into the empty flask, and the baryta-water becomes turbid; after half or three quarters of an hour, the extremity of the first tube is broken off, and air sucked through the apparatus. The baryta is determined as sulphate, and from the weight of the latter, the amount of carbonic acid is calculated.

(1) From the "Berichte der Freunde der Naturwissench. in Wien II, 102" in J. Pr. Chem. XL, 499.

(2) Ann. Ch. Pharm. LXVI, 247, 377.

(3) J. Pr. Chem. XLIV, 253.

Phosphoric acid. Detection.

Phosphoric Acid. Detection.—According to the experiments of Svanberg and Struve(1), molybdic acid is one of the most delicate reagents for phosphoric acid. The solution to be tested is mixed with molybdate of ammonia, and an excess of hydrochloric acid, or better, of nitric acid added; if phosphoric acid be present, the solution assumes a yellow colour, and there appears, either immediately or after some time, a yellow precipitate of molybdate of ammonia containing phosphoric acid. As the native sulphide of molybdenum frequently contains phosphoric acid, it is always necessary to ascertain whether the molybdate of ammonia prepared from it does not give, by itself, the yellow precipitate, upon addition of an excess of acid. H. Rose(2) confirms the extraordinary delicacy of this reaction, which, however, is only applicable to the detection of ordinary phosphoric acid, and not of the other modifications. The yellow precipitate, which is more rapidly produced if the solution be heated, is soluble in ammonia, and in excess of the phosphate employed; it is therefore principally adapted to the recognition of small quantities of phosphoric acid. In the case of phosphates insoluble in water, H. Rose applies this test to the nitric solution.

Estimation.—Raewsky(3) has described a process for the determination of phosphoric acid, which is based, on the one hand, upon the constant composition of the phosphate of sesquioxide of iron and its insolubility in acetic acid, and on the other, upon Marguerite's(4) method of determining the amount of iron, when present in the state of protoxide in a solution, by means of permanganate of potassa. He mixes the moderately acid solution containing phosphoric acid with an excess of acetate of sesquioxide of iron (a solution of 1 part of iron-alum in 10 parts of water, mixed with acetate of soda, answers the purpose), washes well the whitish precipitate of phosphate of sesquioxide of iron upon a filter, dissolves it in hydrochloric acid, and treats the solution with sulphite of soda to reduce the sesquioxide to the state of protoxide. The amount of iron is now determined by means of a standard solution of permanganate of potassa, and the quantity of phosphorus, or of phosphoric acid, calculated according to the formula $Fe_2 O_3$, PO_5; 56 parts of iron (Fe_2) represent 32 parts

(1) J. Pr. Chem. XLIV, 291; Ann. Ch. Pharm. LXVIII, 301.

(2) Pogg. Ann. LXXVI, 26.

(3) Compt. Rend. XXIV, 681; Instit. 1848, 125; J. Pr. Chem. XLI, 365; Repert. Pharm. [2] XLVIII, 51.

(4) Compt. Rend. XXII, 857; Ann. Ch. Pharm. LX, 369.

Phosphoric acid. Estimation.

of phosphorus or 72 of phosphoric acid. Raewsky controlled this process by employing a phosphate of known composition, and believes that it may give results accurate to 6 or 8 thousandths, but it must always be borne in mind, that, as Mitscherlich has shown, the phosphate of sesquioxide of iron is soluble in the acetate, and that, moreover, its constant composition is still questionable.

Raewsky(1) determines the *pyrophosphoric acid* in like manner as the tribasic acid, except that he employs ammonia-iron-alum instead of the acetate of sesquioxide of iron. According to Schwarzenberg (I. p. 265), the pyrophosphate of sesquioxide of iron contains 3 equivs. of acid for 2 equivs. of the sesquioxide.

Estimation by means of Iron and Baryta.—Mulder(2) considers, according to some experiments performed by him regarding the estimation of phosphorus and of phosphoric acid in organic compounds, the method of Berthier (by means of a solution containing a known amount of sesquioxide of iron) as that which yields the most accurate results. The solution of the substance, of fibrin, f. i., in hydrochloric acid, gives the phosphoric acid existing as such, whilst the solution in nitric acid gives the phosphoric acid already existing, together with that produced by the oxidation of the phosphorus; from the difference the amount of phosphorus is calculated. Mulder considers the phosphate of sesquioxide of iron to be soluble in acetic acid; but this is not proved by his experiments, which merely show that it is soluble in acetate of sesquioxide of iron.—Mulder farther considers the weighing as pyrophosphate of baryta ($2\,BaO,\,PO_5$) to be accurate, if chloride of barium be added to the hydrochloric or nitric solution of the organic substance, the solution then filtered, and carefully precipitated with ammonia; Wackenroder and Ludwig(3) have, however, lately proved that this precipitate contains chloride of barium, and is not adapted for the accurate estimation of phosphoric acid.

Estimation by means of Magnesia.—R. Weber(4) has found that ignited phosphate of magnesia, or even phosphate of magnesia-ammonia after having been dissolved in acids, ceases to be entirely

(1) Compt. Rend. XXVI, 205; Instit. 1848, 125.

(2) Scheik. Onderz. IV, 383; J. Pr. Chem. XLV, 282; Repert. Pharm. [2] XLVIII, 36.

(3) Arch. Pharm. [2] LVI, 265, 280.

(4) Pogg. Ann. LXXIII, 137; J. Pr. Chem. XLII, 206; Berl. Acad. Ber. 1848, 239 Instit. 1848, 106.

precipitated by ammonia, the pyrophosphate of magnesia being more soluble than the tribasic combination. The loss may vary, according to circumstances, from 2 to 8 per cent; the presence of ammoniacal salts diminishes it. If the pyrophosphate of magnesia be heated for some time with concentrated sulphuric acid, it becomes again entirely precipitable by ammonia. This deportment is to be borne in mind in the estimation of phosphoric acid or of magnesia. Phosphoric acid. Estimation.

Separation of ordinary Phosphoric Acid from Pyrophosphoric Acid.—H. Rose(1) has shown that ordinary phosphoric acid cannot be separated from pyrophosphoric acid by means of sulphate of magnesia and ammonia in presence of a very large quantity of chloride of ammonium, although pyrophosphoric acid is, under these circumstances, only very slowly precipitated.

Separation of Phosphoric Acid from Sesquioxide of Iron in the presence of the Alkaline Earths.—Fresenius(2), in order to separate phosphoric acid from sesquioxide of iron and the alkaline earths, heats the solution containing these substances to ebullition, and adds sulphite of soda until the colour has changed to a light-green, and carbonate of soda produces a white precipitate; the excess of sulphurous acid is then expelled by boiling, the solution nearly neutralized with carbonate of soda, and mixed with several drops of chlorine-water and an excess of acetate of soda. The smallest quantity of phosphoric acid presents itself in the form of a precipitate of white phosphate of sesquioxide of iron (silicic and arsenic acids also produce a precipitate, and must therefore be previously separated). More chlorine-water is then added, drop by drop, till the liquid assumes a red colour, when it is boiled until colourless and filtered while hot. The filtrate contains the greater part of the iron and the lime, which may be separated by means of sulphide of ammonium. The precipitate contains all the phosphoric acid and the remainder of the iron; we may decompose its hydrochloric solution, either with ammonia and sulphide of ammonium, or after reduction with sulphite of soda, by boiling with an excess of soda. The precipitated proto-sesquioxide of iron is added to the rest of the iron, and the phosphoric acid determined in the filtrate as phosphate of magnesia-ammonia.

Separation of Phosphoric Acid from Alumina.—In the analysis of a compound containing alumina, sesquioxide of iron, lime, magnesia, and phosphoric acid, Fresenius(3) first precipitates the solution,

(1) Pogg. Ann. LXXVI, 28.
(2) J. Pr. Chem. XLV, 258.
(3) J. Pr. Chem. XLV, 263.

Separation of phosphoric acid from alumina.

which has been heated with sulphite of soda in order to reduce the sesquioxide of iron, with carbonate of soda, and then boils with an excess of solution of caustic soda, of which a fresh quantity is added after the precipitate has become black and granular. The solution contains all the alumina and part of the phosphoric acid (if alumina and sesquioxide of iron only have been present, the whole of the phosphoric acid is in the filtrate). The solution is acidified, boiled with chlorate of potassa, precipitated with ammonia and chloride of barium, and filtered after a short digestion. The precipitate, containing the whole of the alumina and phosphoric acid, is slightly washed, dissolved in a sufficient quantity of hydrochloric acid, neutralized whilst hot with carbonate of baryta, and heated with an excess of caustic soda, to which a little carbonate of soda is added, in order to separate any dissolved baryta. The filtrate contains all the alumina, the precipitate all the phosphoric acid. From the hydrochloric solution of the latter, the baryta is separated by sulphuric acid, and the phosphoric acid determined in the filtrate as phosphate of magnesia-ammonia. Fresenius has described, moreover, the method to be followed in the analysis of compounds rich in iron, containing protoxide of manganese, alumina, lime, magnesia, phosphoric, sulphuric, arsenic and silicic acids, and in which, in addition to processes already known, the methods of separation just described are brought into use.—For the methods proposed by Wackenroder we refer to the analysis of ashes.

J. C. Nesbit(1) has shewn that the phosphate of magnesia and ammonia, which is precipitated by means of a mixture of sulphate of magnesia, chloride of ammonium, and ammonia, from solutions of phosphate of sesquioxide of iron and phosphate of alumina in hydrochloric acid, tartaric acid, and ammonia, frequently contains alumina and sesquioxide of iron, unless the solution be much diluted, and mixed with a large excess of tartaric acid and ammonia. Fresenius(2) likewise remarks that this process may lead to errors, since a mixture of tartaric acid, sulphate of magnesia, chloride of ammonium, and ammonia, of a certain concentration, deposits, by itself, a precipitate after some time.

Sulphur. Estimation in Organic Substances.—H. Weidenbusch(3) proposes the following processes for the estimation of sulphur in organic substances. The compound containing sulphur, mixed with an excess of nitrate of baryta, is digested with the strongest fuming

(1) Chem. Soc. Qu. J. I, 44.
(2) J. Pr. Chem. XLV, 259.
(3) Ann. Ch. Pharm. XLI, 372.

Sulphur. Estimation in organic substances.

nitric acid, until the whole of the organic substance is destroyed, which is known by the mass ceasing, after evaporation of the nitric acid, to rise in large bubbles, but drying without intumescence. This mass is now cautiously heated to fusion in a platinum dish, and then treated with dilute acetic acid, which leaves behind the sulphate of baryta to be estimated with the usual precautions.

Heintz(1) burns the substance, placed in a small boat, with protoxide of copper and oxygen-gas, collects the gases in a solution of potassa free from sulphuric acid, treats this solution, as well as the contents of the combustion-tube, with a warm solution of chlorate of potassa in dilute hydrochloric acid, and precipitates the sulphuric acid from the filtrate by means of chloride of barium. If the sulphur-compound leaves a sulphate when incinerated, the residue in the boat has likewise to be added to the solution containing the sulphuric acid.

Oxygen-acids of Sulphur.—Salts of hypochlorous acid convert all the polythionic acids (with exception of hyposulphuric acid) even in the cold, and without an excess of hypochlorite being necessary, immediately into sulphuric acid. Fordos and Gélis(2) make use of this reaction for the estimation of the oxygen and sulphur contained in these acids, which is conducted like a chlorimetrical experiment. A standard solution is first prepared by saturating a dilute solution of soda with chlorine, and adding so much water, that about 25 c. c. of it convert 0·1 grm. of hyposulphite of soda into sulphate. ($NaO, S_2 O_2, 5 H O + 4 Cl = NaO, S_2 O_6, H O + 4 H Cl$; 100 parts of hyposulphite represent 114 of chlorine). 0·1 grm. of the substance is now dissolved in about 100 grms. of water, acidified with hydrochloric acid, and the standard solution added until the odour of chlorine becomes perceptible, or until it bleaches indigo-solution. The number of equivalents of Cl consumed, represent the oxygen-equivalents necessary for the formation of sulphuric acid.—If it be desirable to determine the sulphur, the oxidized solution is precipitated with chloride of barium.

F. Kessler(3), in order to determine the composition of these acids, boils their solutions or those of their salts with a sufficient quantity of cyanide of mercury until the precipitate, at first yellow, has become black, and the supernatant liquid clear. The latter contains part of

(1) Pogg. Ann. LXXI, 145; Ann. Ch. Pharm. LXIV, 403.

(2) Ann. Ch. Phys. [3] XXII, 60; Compt. Rend. XXV, 625; J. Pr. Chem. XLIII, 449.

(3) Pogg. Ann. LXXIV, 265 (and loc. cit. I. p. 285).

Oxygen-acids of sulphur.

the sulphur in the form of sulphuric acid, which is estimated as sulphate of baryta. The precipitate contains the other part of the sulphur, together with a quantity of metal equivalent to the oxygen which was necessary for the formation of sulphuric acid; it is collected upon a weighed filter, dried *in vacuo* over sulphuric acid, weighed, and digested with concentrated nitric acid until the filter is destroyed, then with hydrochloric acid till the sulphide of mercury is dissolved, and lastly heated with chlorate of potassa till the oxidation of the sulphur is completed. The sulphuric acid in the solution is determined in the usual manner, and the amount of sulphur calculated therefrom deducted from the total weight of the black precipitate. The amount of oxygen, equivalent to the metal obtained in this manner, is deducted from the oxygen of the sulphuric acid found in the solution, and thus the amount of oxygen in the polythionic acid is ascertained. With hyposulphites, accurate results are obtained only when nitric acid is added drop by drop to their solution mixed with cyanide of mercury, and the solution is boiled after each addition until the precipitate, at first yellow, has become black. This method is inapplicable to the salts of baryta, strontia, and protoxide of lead.

Separation of Sulphurous Acid from Carbonic Acid.—Persoz(1) avails himself, for the separation of sulphurous acid from carbonic acid, of powdered iodate of potassa or soda strewn upon a glass rod, covered with starch-paste. The glass rod is allowed to remain in the mixture of gases until the absorption is completed, which may be ascertained by means of starch-paste, moistened with a dilute solution of iodate of potassa, and introduced into the tube with a glass rod; the paste immediately becomes blue, if a trace of sulphurous acid still remain.—At an earlier period, Persoz proposed for the same purpose, a concentrated solution of iodate of potassa, which, however, detracted from the accuracy of the experiment by absorbing carbonic acid.

Sulphurous and Nitrous Acids.—Schönbein(2) employs, for the detection of sulphurous or of nitrous acid gas, strips of white unsized printing-paper, moistened with a dilute solution of sulphate of protoxide of manganese, and exposed, after drying, in an atmosphere of ozone (a flask containing air, in which a small stick of phosphorus is placed) till they have become brown from the production of binoxide of manganese. The colour of these strips disappears

(1) Ann. Ch. Phys. [3] XX, 254; J. Pr. Chem. XLI, 287; Ann. Ch. Pharm. LXIV, 408.

(2) Pogg. Ann. LXXII, 457.

Sulphurous and nitrous acids.

immediately in air which contains only traces of sulphurous or nitrous acid, more slowly in an atmosphere of binoxide of nitrogen.—The formation of binoxide of manganese, recognised by the brown coloration of the paper moistened with salts of protoxide of manganese, Schönbein(1) regards as a delicate test for manganese, and conversely for ozone, since, according to his experiments, ozone decomposes no other metallic salt (the basic acetate of lead excepted) with separation of peroxide.

Bromine. Estimation.—Fehling(2) has tested and found useful the method brought into use by Heine(3) for the estimation of bromine in brines. It depends upon the comparison of the colour of the ethereal solution of the bromine liberated by chlorine, with that of a standard solution containing a known quantity of bromine. Fehling prepared ten standard solutions, each containing 60 grms. of a saturated solution of pure chloride of sodium, containing quantities, ascending by 0·002 grm., from 0·002 to 0·020 grm. of bromine, in the form of bromide of potassium. To these solutions an equal volume of ether is added, and then chlorine-water, till the point of most intensive coloration is attained; too little and too much chlorine are alike injurious, since in either case, the colour appears fainter. In this way a proportionally ascending scale of colours is obtained, which serves for the comparison; 60 grms. of the mother-liquor under examination, are now treated in a similar manner, and thus, by comparing the tint of the ether with that of the standard solution, the amount of bromine present is accurately determined within 1 to 2 milligrammes (*i. e.*, within $\frac{1}{60000}$ to $\frac{1}{30000}$). The experiments are confirmed by repetition, taking care to avoid direct solar irradiation, and quickly to terminate the experiment after the addition of the chlorine to the liquid containing bromine.

Fehling has moreover discovered, that by a fractional precipitation of the chlorine from a saturated solution of common salt containing bromine, by means of nitrate of silver, the bromide of silver is precipitated with the first portion of the chloride; when he decomposed a solution containing 0·001 of bromine with from $\frac{1}{5}$ to $\frac{1}{6}$, a solution containing 0·0001 with $\frac{1}{10}$, a solution containing 0·00002 with $\frac{1}{30}$, and one containing 0·00001 with $\frac{1}{60}$ of the silver-solution

(1) Pogg. Ann. LXXII, 466.

(2) From the Würtemb. Wissensch. Jahresheften, 1848, I, 18 in J. Pr. Chem. XLV, 269.

(3) Aus Karsten u. Dechen's Arch. für Mineralog. XIX, 1, in J. Pr. Chem. XXXVI, 184.

Bromine. Estimation.

requisite for complete precipitation, he obtained from the weight of the precipitate after fusion in chlorine-gas, results which were sufficiently accurate, and agreed with those obtained in the estimation of the bromine by the colour of the ethereal solution. The precipitation is best effected in the cold, and the precipitate has usually to be washed for several days.

Iodine and Bromine.—G. L. Cantu(1) effects the simultaneous detection of iodine and bromine in mineral waters, in the following manner. The water is evaporated to one-half, mixed with pure carbonated alkali to alkaline reaction, boiled, filtered, and evaporated to dryness. The residue is treated with alcohol, the extract dried, gently heated, and acidified with acetic acid. The mass, again dried, is dissolved in a little water and mixed with several drops of thin starch-paste. This solution is now carefully poured upon a mixture of 10 parts of sulphuric acid and 1 part of nitric acid, when, in case of iodine- and bromine-compounds being present, there occur two layers in the saline solution, of which the lower is topaz-yellow (sometimes greenish), and the upper blue.—Chevallier and Gobley(2) moisten starch-paper with the aqueous solution prepared in the foregoing manner, and expose it to the gas evolved from a solution of chlorine.

Nitrogen.—For the performance of nitrogen-determinations, according to the method described by Varrentrapp and Will(3), modifications have been proposed by Péligot, Bineau, Mitchell, Nöllner and Schmidt, that of the first-mentioned chemist deserving the most consideration, since it materially shortens the process without affecting its accuracy.

Péligot(4) burns the nitrogenous substance as usual with soda-lime, but instead of receiving the ammonia evolved in hydrochloric acid, and weighing it in the form of the platinum-salt, he conducts it into a known volume or weight of graduated sulphuric acid. (Péligot employs for each experiment 10 c. c. of an acid containing in one litre 61·250 grms. of the monohydrate (HO, SO_3); 100 c. c., therefore, of this acid represent 2·12 grms. of ammonia, or 1·75 grms. of nitrogen). The acid containing the ammoniacal-salt is introduced into a beaker-glass, coloured with a few drops of tincture of litmus,

(1) From the Raccolta Fisico-Chimica Ital. 1848, No. 27 in Chem. Gaz. 1848, 396; Repert. Pharm. [2] XLIX, 374.

(2) J. Chim. Méd. [3] IV, 73.

(3) Ann. Ch. Pharm. XXXIX, 257.

(4) Compt. Rend. XXIV, 550; J. Pharm. [3] XI, 334; J. Pr. Chem. XLI, 122; Ann. Ch. Pharm. LXIV, 402.

and now neutralized with a graduated solution of lime in sugar-water, the point of neutralization being marked by the sudden appearance of a blue tint. By a preliminary experiment, the volume of the lime-solution is known, which saturates 10 c. c. of the above-mentioned graduated acid; in this manner the volume of the acid, saturated by the ammonia (and consequently the weight of the nitrogen), is obtained by subtracting the amount of the acid represented by the lime-solution from the amount (10 c. c.) of pure acid originally employed.—According to a later communication, Péligot(1) replaces the glass tubes in which the combustion with soda-lime is effected, by tubes of sheet-iron, which are about 2 centimetres in diameter, and 80 centimetres in length. In order to avoid drawing the air through the apparatus after the combustion is terminated, he places in the posterior part of the tube, which is closed by an iron stopper, about a gramme of oxalic acid, which when heated together with the soda-lime, evolves hydrogen, which sweeps before it the ammonia contained in the tube. Péligot, moreover, confirms the assertion of Varrentrapp and Will, that, excepting the compounds of nitric acid, all nitrogenous compounds (including the simple and double cyanides) can, by this method, be analysed with an accuracy which leaves nothing to be desired. By the application of his modification, the experiment is terminated in half an hour.

Bineau(2) has even at an earlier period (1846) modified the process in a similar manner, and has substantiated his right of priority(3). He considers the employment of hydrochloric acid, and of solution of caustic soda, as more suitable for the purpose. Mitchell(4) also substitutes for the sugar-lime solution, a solution of soda, of spec. grav. 1·018, and for the tincture of litmus, a decoction of logwood, a few drops of which impart a yellowish-brown tint to the acid liquid, which passes immediately into a blackish-blue, with the smallest excess of alkali.

C. Nöllner(5) receives the ammonia at once in a solution of pure tartaric acid in absolute alcohol, and calculates, from the weight of the crystalline precipitate of bitartrate of ammonia thus produced (which contains 10·2 per cent of NH_3 or 8·4 per cent of N), after drying at 100°, the amount of nitrogen present. The applicability of this modification in the quantitative determination is yet to be

(1) Compt. Rend. XXIV, 1155.
(2) From the Ann. de la Soc. d'Agricult. de Lyon, t. IX, in J. Pharm. [3] XI, 462.
(3) Compt. Rend. XXIV, 686; XXV, 254.
(4) Chem. Soc. Qu. J. I, 19.
(5) Ann. Ch. Pharm. LXVI, 314.

Nitrogen. proved by direct experiments with substances of known composition.

E. Schmidt(1) conducts the ammonia, together with a stream of carbonic acid, into a solution of 1 part of chloride of barium in 8 parts of water, heats to ebullition, filters, and calculates the amount of nitrogen from the weight of the ignited carbonate of baryta.

Alterations in the form of the ordinary bulb-apparatus for the absorption of the ammonia in these determinations have been proposed by Kemp(2), Warren De La Rue(3), Th. Taylor(4), and Horsford(5).

Delbrück(6) has described a method proposed by Marchand for the determination of the relative quantities of nitrogen and carbonic acid, in which, as in Bunsen's process, the air is expelled from the combustion-tube by means of hydrogen. Delbrück draws out a combustion-tube at one extremity into a fine point, introduces first a plug of asbestos, then the substance (of which 20 milligrms. suffice) mixed with protoxide of copper; after this, more asbestos, then a long layer of pure protoxide, and lastly a similar layer of reduced copper. The foremost end of the tube is now drawn out at right angles to it, to the length of a barometer-tube, and the apparatus filled with hydrogen. When all the air is expelled, the gas-delivery-tube is sealed, and then the end through which the hydrogen entered; the tube is now laid in a combustion-furnace, the foremost point broken off under mercury, and the fore part of the tube heated, care being taken to avoid the application of heat to the mixture. When all the hydrogen is absorbed, which is known by the mercury ceasing to rise, the mixture is heated, and the gas now evolved conducted into a graduated tube. The volume of gas is measured, the carbonic acid absorbed by a potassa-ball, and the volume of the residual nitrogen read off. The determinations of nitrogen in caffeine, uric acid and indigo, made by Delbrück according to this method, satisfy all demands of accuracy.

Nitric Acid.—W. Crum(7) describes a method for the analysis of compounds of nitric acid, which consists essentially in decomposing

(1) From the Polyt. Centralbl. in Arch. Pharm. [2] L, 317.
(2) Chem. Gaz. 1847, 144.
(3) Phil. Mag. [3] XXXI, 156; Chem. Soc. Mem. III, 347.
(4) Phil. Mag. [3] XXXI, 326; Chem. Soc. Mem. III, 318.
(5) Sill. Am. J. [2] IV, 266.
(6) J. Pr. Chem. XLI, 177.
(7) Ann. Ch. Pharm. LXII, 233; J. Pr. Chem. XLI, 201; Phil. Mag. [3] XXX, 426; Repert. Pharm. [2] XLVII, 81.

Nitric acid.

the substance in a graduated tube over mercury, with a large excess of concentrated sulphuric acid, and measuring the binoxide of nitrogen evolved by the action of the liberated nitric acid upon the mercury. When, after several hours, the tube having been frequently shaken, no farther increase of volume is perceived, a concentrated solution of sulphate of protoxide of iron is introduced, and the volume of gas which is not absorbed (the nitrogen of the air introduced) subtracted from the whole. W. Crum determined, with the aid of this method, the nitric acid contained in gun-cotton, after having convinced himself of its accuracy by testing it with pure nitre.

Gossart(1) has applied Gay-Lussac's principle of chlorimetry to the determination of the purity of nitre designed for the fabrication of gunpowder. A solution of the crude nitre, of known strength, is mixed, first with sulphuric acid, and then with an acid solution (graduated by means of pure nitre) of sulphate of protoxide of iron, until after heating, addition of ferricyanide of potassium shows that all the protoxide of iron is converted. Pelouze(2) has modified this process in the following manner. He determined, by accurate experiments, that 2 grms. of iron (piano-wire) dissolved in from 80 to 100 grms. of hydrochloric acid, require from 1·212 to 1·220 (as a mean, therefore, 1.216) grms. of pure nitre for its entire conversion into the salt of sesquioxide of iron, whereby only binoxide of nitrogen is evolved. The equation $6\,Fe\,Cl + K\,O, N\,O_5 + 4\,H\,Cl = 4\,H\,O + K\,Cl + N\,O_2 + 3\,Fe_2\,Cl_3$, accurately represents the reaction; 168 (6 eq.) of iron, therefore, require 102 (1 eq.) of nitre. Chlorine-compounds and sulphates are without influence upon the result, but the nitre contaminated with either of them, converts a proportionally smaller quantity of iron into sesquioxide; Pelouze now determines the amount of iron which is still present as protoxide, after treatment with a weighed amount of the nitre to be tested, and thence calculates the amount of nitric acid or of nitre present. The following is the method made use of: 2 grms. of piano-wire are dissolved by being heated with concentrated hydrochloric acid in a flask capable of holding about 150 c. c., and closed by a cork, through which passes a tube drawn out to a point; 1·200 grms. of the nitre to be tested are then introduced into this solution, and the cork having been replaced, the whole is heated to ebullition. After five or six

(1) Compt. Rend. XXIV, 21.

(2) Ann. Ch. Phys. [3] XX, 129; Compt. Rend. XXIV, 209; Ann. Ch. Pharm. LXIV, 399; J. Pr. Chem. XL, 324.

Nitric acid.

minutes, the solution, which has again become clear, is poured together with the washings, into a flask, and diluted with water to about a litre. The protoxide of iron still present is now determined, according to the process described by Marguerite(1), by means of a graduated solution of permanganate of potassa, which is added until the solution has assumed a faint rose-red tint. Let, f. i., 50 c. c. of the solution of permanganate of potassa be required for the oxidation of 1·000 grm. of iron, and suppose that in the experiment under consideration, only 10 c. c. have been employed, it then will be evident that there were $\frac{1000 \cdot 10}{50} = 0{\cdot}200$ of iron still present as protoxide, which, therefore, must be subtracted from the 2 grms. of iron employed. Accordingly, 1·200 grms. of nitrate of potassa have in this case converted 1·800 of iron into sesquioxide; but 1·000 grm. of iron requiring 0·608 of pure nitre, there was present only $1{\cdot}8 \times 0{\cdot}608 = 1{\cdot}094$ grms., or, since 1·200 grms. of crude nitre was employed, 91·2 per cent of pure nitre. Pelouze asserts that by means of this method, the nitric acid present may be determined accurately within 0·002 or 0·003.

Ammonia.—For the detection of small quantities of ammonia, Wackenroder(2) places the solution to be tested, mixed with caustic alkali, in a watch-glass, covers the latter with white blotting-paper which has been moistened with some solution of sulphate of copper or of manganese, and places a glass plate over the whole. The liberated ammonia produces in the one case an azure-blue, in the other a brown stain. J. Müller(3) employs for the same purpose, and also as a sympathetic ink, a concentrated solution of nitrate of suboxide of mercury, when the paper immediately becomes black.

Detection of Potassa and Soda by the Blow-Pipe.—E. J. Chapman(4) announces that potassium or sodium may be recognized in the presence of magnesia in the following manner. A bead of pure boracic acid is fused in a loop of platinum wire, the saline mass mixed with a little protoxide of copper is introduced by degrees, and the bead exposed to the oxidizing flame. If magnesia alone be present the greater portion remains undissolved, and the bead is colourless; potassa and soda, on the other hand, dissolve immediately

(1) Ann. Ch. Phys. [3] XVIII, 244; Ann. Ch. Pharm. LX, 369; Berzelius' Jahresber. XXVII, 215.

(2) Arch. Pharm. [2] XLVIII, 30.

(3) Arch. Pharm. [2] XLIX, 28; Repert. Pharm. [2] XLV, 64.

(4) Chem. Gaz. 1847, 372.

with the protoxide of copper to a bead, green whilst hot, and blue on cooling. If the alkaline salt be in excess, the magnesia is likewise dissolved; in the opposite case it remains undissolved, but the colour of the protoxide of copper becomes nevertheless apparent. Baryta and strontia comport themselves like the alkalies towards boracic acid and protoxide of copper.

Detection of potassa and soda by the blow-pipe.

Detection and Estimation of Soda in Potashes.—According to Fremy(1), ½ per cent of soda may be recognised in potashes by means of metantimoniate of potassa (for its preparation, see I. p. 329). About 1 grm. of the potash is dissolved in water, supersaturated with hydrochloric acid, evaporated to dryness, and the perfectly neutral solution of the chloride of potassium in a little water mixed with metantimoniate of potassa. If 2 or 3 per cent of soda be present, there appears almost instantaneously, with a smaller quantity only after some time, a precipitate, the formation of which is accelerated by agitation.

Pagenstecher(2) has published a process for the estimation of soda in potashes, which depends upon the faculty of a saturated solution of sulphate of potassa to dissolve sulphate of soda. He converts a weighed amount of the potashes by treatment with an excess of sulphuric acid and ignition, into neutral sulphate, which is again weighed, and agitated twice with six times its quantity of a saturated solution of sulphate of potassa. The residue, after draining, is weighed, first moist, then when dried at 100°. The difference is the evaporated water of the solution of sulphate of potassa the concentration of which was known; if the amount of salt which it represents be deducted from the total weight of the saline residue, there is obtained, if the potashes were free from soda, the original quantity of sulphate of potassa, in the other case, the amount of soda present is calculated from the loss of weight which represents the sulphate of soda.

Magnesia. Separation from the Alkalies.—In order to separate magnesia from the alkalies, according to Sonnenschein(3) their combinations, which have been converted into chlorides, are evaporated to dryness, gently heated, dissolved in water, and boiled with washed carbonate of silver (prepared by precipitation with carbonate of ammonia, and washing) until the supernatant liquid exhibits a powerfully alkaline reaction. From the hot filtrate a trace of the

(1) Ann. Ch. Phys. [3] XXIII, 410.
(2) J. Pr. Chem. XLII, 137.
(3) Pogg. Ann. LXXIV, 313.

Magnesia. Separation from the alkalies.

silver-salt is removed by hydrochloric acid, and the alkalies estimated therein in the ordinary manner. From the residue on the filter the magnesia is extracted with hydrochloric acid, and precipitated with ammonia and phosphate of soda.

Heintz(1) adds to the solution which contains magnesia, potassa and soda, an excess of ammonia, and unless a sufficient quantity of chlorine-compounds be present, some chloride of ammonium, and precipitates the magnesia with phosphate of ammonia. The phosphoric acid is precipitated from the filtrate freed from ammonia by evaporation, by means of an excess of nitrate or acetate of lead, the latter removed from the hot filtrate by ammonia and carbonate of ammonia, and the potassa and soda determined according to the known methods. The phosphate of ammonia made use of in this process should not have been prepared with the acid obtained from bones, which uniformly contains soda. The presence of chlorine-compounds induces the formation of a compound of tribasic phosphate of protoxide with protochloride of lead, which combination yields no acid to the ammonia.—Erdmann(2) also has applied this easy method of separation to the analysis of the ashes of plants.

Distinction between Lithium and Strontium before the Blow-Pipe.—According to Plattner's(3) statement, chloride of barium prevents the red tint of the outer blow-pipe-flame which chloride of strontium alone imparts to it. E. J. Chapman(4) makes use of this reaction for the distinction between lithium and strontium, the former reddening the flame even in the presence of chloride of barium. According to Reinsch(5) the red tint of strontium is imparted very distinctly to the flame, if the mineral containing strontia be moistened with hydrochloric acid, and brought in contact with the lower blue margin of the flame; an addition of chloride of barium does not, in this case, entirely remove the red colour, but merely impairs its intensity.

Sulphate of Lime.—Lassaigne(6) determines the amount of gypsum present in common salt, by treating the latter with a solution of gypsum saturated at 20^0, and weighing the residue washed with the same solution.

Carbonate of Lime.—Bineau(7) has published a process for the

(1) Pogg. Ann. LXXIII, 119.
(2) J. Pr. Chem. XLI, 89.
(3) Plattner, the use of the Blow-pipe, translated by Muspratt.
(4) Chem. Gaz. 1848, 188.
(5) Jahrb. Pr. Pharm. XVII, 214.
(6) J. Chim. Méd. [3] III, 425.
(7) From the Mém. de la Soc. Royale d'Agricult. etc., de Lyon, Avril 1847, in J. Pharm. [3] XII, 301.

Carbonate of lime.

expeditious determination of the amount of carbonate of lime contained in limestone, marl, soils, and waters. The finely-divided substance is heated in a tubulated retort with an excess of graduated dilute hydrochloric acid, the weight of which has been previously ascertained. When a few drops condense in the retort-neck, a receiver is applied, and the mixture boiled till no farther reaction takes place. The contents of the receiver are now mixed with those of the retort, coloured with neutral litmus-tincture, and a standard solution of caustic alkali added from a graduated burette, until the colour changes to blue. If the limestone contain magnesia, its quantity is determined by adding sugar-water to the solution, which is then mixed with caustic alkali as long as there appears any precipitate, which consists of magnesia only, since the precipitation of the lime is prevented by the sugar. If too much alkali has been added, the magnesia is filtered off, and the excess determined by the gradual addition of the standard acid. The magnesia being estimated, we must always, in order to calculate the amount of lime present, subtract from the quantity of acid originally employed, not only that which was found to be in excess, but also that represented by the alkali which served for the precipitation of the magnesia. The presence of alumina or sesquioxide of iron is without influence upon the result; the protoxides of iron and manganese deteriorate the estimation of the magnesia, but not that of the lime. If the carbonate of lime be dissolved in water, the graduated acid is added at once, and the carbonic acid expelled by heat. In the presence of alkaline carbonates, or other salts possessing an alkaline reaction, the carbonate of lime is precipitated by boiling, and the precipitate treated as above. Bineau assumes for this process, that 4 milligrms. of carbonate of lime are retained in solution in each decilitre of water.

Carbonate of Lime in Water.—A. Dupasquier(1) has proposed for the detection of bicarbonate of lime in water, an alcoholic tincture of logwood, to which it imparts a violet tint. In order to be sure that this coloration is not occasioned by the presence of alkaline carbonates, he mixes one portion of the water with sulphate of copper, another with chloride of calcium. If bicarbonate of lime only be present, the latter produces no turbidity, whilst the former precipitates carbonate of copper, from the quantity of which Dupasquier deduces that of the bicarbonate of lime. If the water be very poor in alkaline carbonate, and rich in free carbonic acid, the

(1) Compt. Rend. XXIV, 628; J. Pharm. [3] XI, 340; J. Pr. Chem. XLI, 94.

Carbonate of lime in water.

precipitation by chloride of calcium takes place only when the water is freed from an excess of carbonic acid by the careful application of a heat short of ebullition. The bicarbonate of lime present is precipitated as carbonate, only by continuous boiling, and attaches itself to the sides of the vessel, whilst the carbonate of lime precipitated by the alkaline carbonate produces a turbidity throughout the whole mass of the liquid.

Molybdenum.—According to H. Rose(1), molybdenum is best determined in the form of binoxide ($Mo\,O_2$), into which the acid, its ammonia-salt, or the molybdate of suboxide of mercury precipitated from a neutral solution, is converted by heating over a spirit lamp in an atmosphere of hydrogen. The last-mentioned salt is washed with a very dilute solution of subnitrate of mercury, weighed upon a filter dried at 100°, and part of it then reduced with hydrogen. The estimation is less accurate when the alkaline molybdate is repeatedly ignited with chloride of ammonium, and the binoxide remaining after washing with water, weighed upon a filter dried at 100°.

Chromium.—H. Vohl(2) makes use of the deportment which chromic acid exhibits with oxalic acid, and which is analogous to that of the peroxides, for the quantitative estimation of chromium. When the chromium is present as chromic acid, the experiment is performed in the same manner, and in the same apparatus as the estimation of manganese according to the method of Will and Fresenius. 2 equivs. (100·62 parts) of chromic acid yield with 3 equivs. of oxalic acid, 6 equivs. (132 parts) of carbonic acid, ($2\,CrO_3 + 3\,C_2\,O_3 = Cr_2\,O_3 + 6\,CO_2$. In the analysis of a salt of chlorochromic acid, protoxide of mercury is previously added, in order to retain the chlorine. If the chromium be present as sesquioxide, Vohl proposes to mix the aqueous solution with potassa in excess, until the sesquioxide is redissolved, and then to pass chlorine through the solution which has to be kept cool until its colour changes to a yellowish-red. It is now mixed with free potassa, evaporated to dryness, ignited, and the mixture of the chromate with chloride of potassium, after addition of protoxide of mercury, treated as above.

Estimation of the value of Manganese.—De Vry(3) calls attention to the fact that the variable amount of water contained in manganese-

(1) Pogg. Ann. LXXV, 319; J. Pr. Chem. XLV, 239; Ann. Ch. Pharm. LXVIII, 374; Berl. Acad. Ber. 1848, July; Institut. 1849, 13.

(2) Ann. Ch. Pharm. LXIII, 398; J. Pr. Chem. XLIII, 398.

(3) Ann. Ch. Pharm. LXI, 249.

ore, sometimes amounting to 15 per cent, causes a variation in the result of the determination of its value, which renders it desirable to expel in every case the water, and to examine the dried manganese-ore.

Arsenic, molybdenum, &c., in minerals.

Arsenic, Molybdenum, &c., in Minerals.—R. D. Thomson(1) recommends for the examination of minerals for arsenic, molybdic, vanadic acid, &c., to digest them in the state of fine powder with sulphide of ammonium, and to evaporate the filtrate, when the dissolved metallic sulphide remains behind.

Estimation of Arsenic.—Kobell(2) proposes, for the quantitative determination of arsenic, to ascertain the amount of copper which is dissolved, when, according to the process of Reinsch(3), the arsenical liquid mixed with free hydrochloric acid is boiled with metallic copper without access of air. The arsenic must be present as arsenic acid, and the solution free from nitric acid, or any other substance capable of oxidizing the copper. In the solution of subchloride of copper decanted from the undissolved metal, the copper is determined, after oxidation with chlorate of potassa, either according to the method of Fuchs by boiling with weighed copper strips, or by that of Levol, in which the loss of weight suffered by the copper slips in the solution of protochloride of copper with excess of ammonia, is determined.

Werther(4) considers arseniate of sesquioxide of uranium, which, according to his experiments is insoluble in water, acetic acid, and chloride of ammonium, in many cases, as an appropriate form for the estimation of arsenic. The easy reducibility of the precipitate with loss of arsenic, and the great propensity of sesquioxide of uranium to form double compounds will always limit the employment of this form for the determination of arsenic when compared with that of arseniate of magnesia.

Detection of Arsenic in Judicial Cases.—G. Reich(5) has described the method followed by him for the detection of arsenic in judicial cases, and the apparatus employed therein. We refer the reader to the treatise, since the method is already known, and the modifications of Marsh's apparatus proposed by Reich cannot be clearly described without the aid of drawings.

(1) Phil. Mag. [3] XXXI, 258; J. Pr. Chem. XLII, 434.

(2) From Gelehrt. Anz. d. Baier. Acad. in J. Pr. Chem. XLI, 156; Ann. Ch. Pharm. LXIV, 410.

(3) J. Pr. Chem. XXIV, 244; Berzelius' Jahresber. XXII, 174.

(4) J. Pr. Chem. XLIII, 346.

(5) Arch. Pharm. [2] LV, 1.

Judicial chemical analysis.

Judicial Chemical Analysis.—Abreu(1), a Brazilian physician, has laid before the Academy of Sciences of Paris, the description of his method of detecting poisonous metals (arsenic, antimony, mercury, copper, lead, tin, zinc, and silver), in solid or liquid organic matters. Also this process presents nothing new. He destroys the organic matters—after they have been explored by means of a lens for metallic poisons in the solid form—at a boiling heat by means of fuming hydrochloric acid and the gradual addition of chlorate of potassa, in a flask, with the precaution that the evolved gases must pass through water, and precipitates the filtrate freed from excess of chlorine and mixed with the wash-water, by sulphuretted hydrogen. The precipitated sulphides (the zinc of course remains in solution, and the silver in the residue as chloride), are redissolved in hydrochloric acid and chlorate of potassa, and tested by the known accurate methods for the individual metals.

Lassaigne(2) recommends for the extraction of arsenic from solid animal matters, the successive treatment of these substances, first with concentrated sulphuric acid, and then with nitric acid. After the expulsion of the latter by boiling, he dilutes with 5 or 6 volumes of water, filters, and introduces the liquid into Marsh's apparatus. It produces no foam, even though it be still coloured.—Filhol(3) prefers to destroy the organic matter with nitric acid to 100 grms. of which from 12 to 15 drops of concentrated sulphuric acid are added, since in this case, the operation need not be performed in closed vessels, as a volatilization, neither of chloride of arsenic, nor, as Boisgiraud states to have observed, of sulphide of arsenic, is to be apprehended.

Distinction between Arsenic- and Antimony-Spots.—In order to ascertain whether the spot produced upon a porcelain plate by Marsh's method proceeds from arsenic, Filhol places the plate over a capsule in which is contained a solution of bleaching-powder mixed with dilute sulphuric acid; as soon as the spots (after one or two minutes) have disappeared, he drops upon the plate a concentrated solution of nitrate of silver, when there appears immediately a brick-red tint, or even a precipitate of arseniate of silver.

On mentioning the method proposed by Cottereau(4) of distin-

(1) Compt. Rend. XXVII, 218.
(2) J. Chim. Méd. [3] IV, 967.
(3) J. Pharm. [3] XIV, 404; J. Chim. Méd. [3] IV, 543.
(4) J. Chim Méd. [3] II, 330.

Distinction of arsenic- and antimony-spots.

guishing arsenic- from antimony-spots by means of phosphorus which is being volatilized in atmospheric air, Berzelius(1) raised the question whether in this case the arsenic is not oxidized, sooner than the antimony, by the ozone produced in this process. Schönbein(2) has now shown, that under these circumstances the arsenic is actually converted into arsenic acid, and indeed, only under those conditions in which he has observed the formation of ozone. If the phosphorus is volatilized in perfectly dry or in moist air charged with ether-vapour or olefiant gas, the arsenic-spots do not disappear; they are, however, oxidized, and indeed more rapidly than antimony-mirrors of equal thickness, when held close before an obtuse metal point from which a lively current of electricity is discharged. Arsenic and arsenious acid are converted into arsenic acid also by binoxide of hydrogen.

When Gaisney(3) intended to test for arsenic a liquid which was designed for embalming a dead body, he remarked that the evolution of hydrogen ceased when the liquid to be examined was introduced into Marsh's apparatus. It contained in solution a salt of mercury which amalgated the zinc in such a manner as to prevent its action upon the acid.

Separation of Arsenic from Tin.—According to the experiments of Gay-Lussac(4) commercial tin dissolves in a mixture of 1 equiv. of nitric acid and 9 equivs. of hydrochloric acid at a gentle heat, to produce protochloride of tin, without evolution of gas, whilst the constant impurity of tin, the arsenic, remains behind as an easily-collected powder. The tin, for this purpose, is laminated, or granulated by pouring it in the fused state into water. As is evident from the equation $NO_5 + 9\,HCl + 8\,Sn = 8\,Sn\,Cl + N\,H_4\,Cl + 5\,HO$, the aqua regia must not be employed in a proportion much exceeding that of 1 equiv. of nitric and 9 equivs. of hydrochloric acid for 8 equivs. of metal.

Separation of Tin and Antimony.—H. Rose(5) has published a method of separating tin and antimony which depends upon the insolubility of the antimoniate, and the solubility of the stannate of soda.—The metals are oxidized with strong nitric acid, the dry oxides fused with excess of hydrate of soda in a silver crucible, and treated

(1) Berzelius' Jahresber. XXVII, 223; Ann. Ch. Pharm. LXIV, 420.
(2) Pogg. Ann. LXXV, 361.
(3) J. Chim. Méd. [3] III, 638.
(4) Ann. Ch. Phys. [3] XXIII, 298 (compare I. 295).
(5) Pogg. Ann. LXXI, 301; Ann. Ch. Pharm. LXIV, 404; J. Pr. Chem. XLI, 221: Berl. Acad. Ber. 1847, May, 151.

Separation of tin and antimony.

with warm water. The *clear* and *cold* solution of stannate of soda is filtered off, and the antimoniate of soda washed by not too long continued decantation, wherein care must be taken, that the wash-water be not poured on the filter before it be cold and perfectly transparent. It easily becomes clear upon addition of some carbonate of soda. The antimoniate of soda is, while yet moist, dissolved in a mixture of hydrochloric and tartaric acids, precipitated with sulphuretted hydrogen, and the tersulphide of antimony reduced at a gentle heat by hydrogen in a porcelain crucible, the cover of which is furnished with a thin porcelain tube. From the solution of stannate of soda acidified with hydrochloric acid, the tin is precipitated as bisulphide, the latter converted into binoxide by roasting, and weighed. This method gives the antimony somewhat too high, since a small quantity of binoxide of tin often remains with the antimoniate of soda.

Separation of Arsenic and Antimony.—The method of Rose for the separation of tin and antimony is closely allied to that of separating arsenic from the same metal, which C. Meyer(1) has described. He deflagrates the antimony containing arsenic with three times its weight of a mixture of nitre and carbonate of soda, exhausts with cold water, ignites, and determines the weight of the residual antimoniate of soda (NaO, SbO_5). In the filtrate, perfectly free from antimony, the arsenic is determined by one of the known methods, very appropriately as arseniate of magnesia, by precipitating with sulphate of magnesia, chloride of ammonium and ammonia. If the two metals exist as sulphides, they are dissolved, according to Meyer, together with the filter, in hot nitric acid, the solution is saturated with carbonate of soda, some nitrate of soda added, the mixture evaporated in a porcelain crucible, and fused till the oxidation is complete. After exhaustion with water NaO, SbO_5 remains.—If a solution of antimoniate of potassa be mixed with sulphate of soda, all the antimony is precipitated as hydrated antimoniate of soda, $NaO, SbO_5, 6\,H\,O$, insoluble in cold, somewhat soluble in hot water. This process Meyer recommends also for the preparation of antimony free from arsenic, according to Wöhler's plan. (See I. p. 325).

Distinction of Bismuth and Lead.—To detect small quantities of lead in bismuth or in bismuth-compounds, Chapman(2) brings the somewhat flattened bead, reduced before the blow-pipe, in contact

(1) Ann. Ch. Pharm. LXVI, 236.

(2) Chem. Gaz. 1848, 373; Phil. Mag. [3] XXXIII, 319.

with some moist basic nitrate of teroxide of bismuth, when in a short time, in consequence of the reduction of the bismuth by the lead, arborescent sprigs of metallic bismuth are formed around the test-specimen. Since zinc and iron interfere with this reaction, they must be previously removed, the former by fusion with soda, the latter with soda and borax in the reducing flame. Distinction of bismuth and lead.

Iron. Precipitation of it by Sulphide of Ammonium. — Blumenau(1) has found that a considerable excess of alkaline carbonate prevents the precipitation of iron from its solution in an alkaline tartrate by means of hydrosulphate of sulphide of potassium, or hydrosulphate of sulphide of ammonium. By careful neutralization with an acid, all the iron is precipitated as sulphide.

Distinction between Sesquioxide and Protoxide of Iron.—In order to distinguish before the blow-pipe, sesquioxide from protoxide of iron, the substance to be tested is heated, according to Chapman(2), for a short time in the reducing blow-pipe-flame, upon platinum wire, with a borax-bead coloured of a pale blue, by means of protoxide of copper. If protoxide of iron be present, there appear in this case red streaks or spots, in parts where it reduces the protoxide of copper to the state of suboxide. Since the same reduction may be produced also by too long continued blowing, even when the iron is present as sesquioxide, a second borax-bead is fused with so much protoxide of copper, that it is distinctly blue on cooling, but clear and transparent; this bead is now heated in the oxidizing flame with the finely powdered substance, only until the latter begins to dissolve. If only sesquioxide of iron be present, the bead when cool is bluish-green and clear; protoxide of iron produces opaque red spots. But even here too long continued blowing renders the test unsafe.

Separation of Sesquioxide of Iron from Alumina.—For the separation of sesquioxide of iron from alumina, according to Fresenius(3), the acid solution containing the two oxides is treated, at a boiling heat, with sulphite of soda to reduce the sesquioxide of iron, mixed with carbonate of soda, and now boiled with an excess of caustic soda till the precipitate has become black and granular. The filtrate containing all the alumina is boiled with hydrochloric acid and chlorate of potassa, and precipitated by ammonia. The treatment with chlorate of potassa destroys the organic matter derived from the paper by the

(1) Ann. Ch. Pharm. LXVII, 125.
(2) Phil. Mag. [3] XXXII, 309; Chem. Gaz. 1848, 106.
(3) J. Pr. Chem. XLV, 261.

Separation of nickel and cobalt.

caustic soda, which would prevent the complete precipitation of the alumina.

Separation of Nickel and Cobalt.—For the quantitative separation of nickel from cobalt, methods have been described by Liebig and H. Rose, both of which, in facility of execution and accuracy of results leave nothing to be desired.—Liebig had, at an earlier period, proposed a method for separating these two bodies by means of cyanide of potassium and hydrochloric acid, a process which involved some difficulties; he has now(1) improved this process in the following manner. He mixes the solution of the two oxides, free from iron and manganese, with hydrocyanic acid and then with potassa, and heats until the whole is dissolved (cyanide of potassium, free from cyanate, may likewise be employed). The reddish-yellow solution is boiled to expel the free hydrocyanic acid; by this means the cyanide of cobalt and potassium (Co Cy, K Cy) is converted, with evolution of hydrogen, into cobalticyanide of potassium (K_3 Co_2 Cy_6); the nickel is contained in the solution as cyanide of nickel and potassium (Ni Cy, K Cy). Some finely-powdered and well-washed protoxide of mercury is now added to the warm solution, whereby the whole of the nickel is precipitated, partly as oxide, partly as cyanide, its place being occupied by the mercury. If the liquid was neutral before the addition of the protoxide of mercury, it becomes alkaline after boiling with this oxide. The precipitate, at first greenish, but becoming by an excess of protoxide of mercury, yellowish-grey, is washed and ignited; it is then pure protoxide of nickel. The filtrate is supersaturated with acetic acid, precipitated while boiling, by sulphate of protoxide of copper, and the precipitate kept boiling for some time with the solution, till it has lost its slimy appearance. It is cobalticyanide of copper, Cu_3 Co_2 $Cy_6 + 7$ HO. The amount of cobalt contained therein may be determined either directly or indirectly, by separating the copper in the form of protoxide, by means of potassa, and weighing. If the cobalt is to be determined directly, the precipitate is washed, dried, ignited, and dissolved in hydrochloric acid, with addition of some nitric acid, the copper precipitated with sulphuretted hydrogen, and the protoxide of cobalt, after expulsion from the solution of the sulphuretted hydrogen, precipitated by boiling with solution of potassa, and reduced as usual by means of hydrogen.

It is evident that this method is simpler, when the total weight of the two oxides, or of the metals reduced by hydrogen, has been

(1) Ann. Ch. Pharm. LXV, 244.

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determined, and only the nickel is to be estimated.—In addition, Liebig gives still several suggestions for another mode of separating the two metals, which deserves a farther trial. The mixture of protoxides of nickel and cobalt is treated with hydrocyanic acid and then with ammonia, when cobalticyanide of ammonium and cyanide of nickel and ammonium are produced. To this solution, sulphide of ammonium and sulphur are added, when the liquid becomes of a deep black, and upon boiling, clear, with separation of sulphide of nickel free from cobalt. The solution contains, together with cobalticyanide, sulphocyanide of ammonium.

A solution of protochloride of cobalt, mixed with free hydrochloric acid, when treated with chlorine, is entirely converted into sesquichloride, whilst chloride of nickel is not altered. Upon this deportment depends the following method described by H. Rose(1) for the separation of the two metals. Their hydrochloric solution, mixed with a sufficient quantity of free acid, is diluted with much water (with about 1 litre for 2 grms. of metallic oxide), and treated with chlorine-gas for several hours, till it is entirely saturated therewith, the empty space of the flask being likewise filled with it. Carbonate of baryta in excess is now added, the whole allowed to stand in the cold for twelve or eighteen hours, with frequent agitation, and the precipitated sesquioxide of cobalt collected, together with the excess of carbonate of baryta, on a filter. After washing with cold water, the precipitate is dissolved in hot hydrochloric acid, the baryta removed with sulphuric acid, the protoxide of cobalt precipitated with solution of potassa, and, after washing and drying, reduced with hydrogen in a platinum or porcelain crucible. From the liquid filtered from the sesquioxide of cobalt, the baryta is first precipitated by means of sulphuric acid, and then the protoxide of nickel separated by an alkali.

T. H. Henry(2) employed with great success, a solution of bromine instead of chlorine; he states, moreover, with reference to the method previously proposed by Liebig for the separation of these two metals, that a solution of cobalticyanide of potassium boiled for a long time with hydrochloric acid, or evaporated nearly to dryness with sulphuric acid, is decomposed with evolution of hydrocyanic acid, in such a manner as to yield a precipitate of oxide of cobalt with the alkalies. He ascribes to this deportment, the excess of

(1) Pogg. Ann. LXXI, 545; Ann. Ch. Pharm. LXIV, 411; J. Pr. Chem. XLII, 136; Berl. Acad. Ber. 1837, 114; Chem. Gaz. 1847, 362.

(2) Chem. Gaz. 1847, 370.

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nickel, which he, as well as H. Rose, obtained in following this method(1). Henry likewise obtained too much cobalt, when, according to the method proposed by Plattner(2), the precipitated oxides were heated, first with arsenic in a glass tube, then fused upon charcoal in the inner flame till the excess of arsenic was volatilized, and, after weighing, treated with borax in the outer flame till all the cobalt was oxidized and dissolved, when the remaining arsenide of nickel was weighed.

Separation of Nickel and Cobalt from Manganese.—The statement of Barreswill(3), that cobalt may be separated from manganese by passing sulphuretted hydrogen into the solution mixed with excess of carbonate of baryta, has been tested by Strecker(4) and by H. Rose(5), and, as might have been anticipated, found inapplicable, since the manganese is also precipitated. The separation of nickel from manganese is best effected, according to H. Rose, like that of nickel from cobalt, by means of chlorine and carbonate of baryta; for the separation of nickel and cobalt from manganese, he recommends to precipitate the ammoniacal solution free from nitric acid, with sulphide of ammonium, and to acidify with hydrochloric acid, by which the manganese is redissolved; a process which agrees essentially with that previously proposed by Wackenroder(6).

Separation of Protoxide of Nickel from Alumina. — According to H. Rose, alumina cannot be separated from protoxide of nickel by boiling with solution of potassa; but this separation is well effected by fusion with hydrate of potassa in a silver crucible; since in this case the protoxide of nickel which remains behind contains potassa, and must be once redissolved, he prefers the separation of the two by means of carbonate of baryta.

Copper.—In reference to the method described by Pelouze(7) in 1846, for the quantitative determination of copper by means of a standard solution of sulphide of sodium, Casaseca(8) communicates to the Parisian Academy the fact, that in 1845 he had, in a letter to

(1) In Liebig's new method (II. p. 224) this source of inaccuracy is removed.

(2) The use of the Blow-pipe, translated by Muspratt.

(3) Ann. Ch. Phys. [3] XVII, 53; J. Pr. Chem. XXXVIII, 171; Berzelius' Jahresber. XXVII, 214.

(4) Ann. Ch. Pharm. LXI, 219.

(5) Pogg. Ann. LXXI, 645; Ann. Ch. Pharm. LXIV, 416.

(6) Arch. Pharm. [2] XVI, 126; L. Gmelin's Handb. III, 338.

(7) Ann. Ch. Phys. [3] XVI, 417; XVII, 393; Berzelius' Jahresber. XXVII, 217.

(8) Compt. Rend. XXVI, 273.

Pelouze, described a process for the quantitative determination of copper by the comparison of the tint of the ammoniacal solution of the protoxide, with that of a similar solution of known strength. Upon the same principle rests the method made known by Jacquelain(1); Pelouze(2) does not deem this method sufficiently accurate; Huber(3), however, states, that in simplicity and accuracy it is inferior to none of the known processes. Copper.

C. Riegel(4) communicates a synopsis of the methods employed up to the present time, for the detection and estimation of copper; according to his comparative experiments, the above-mentioned method of Pelouze gives very accurate results.

Cupellation of Silver before the Blow-pipe.—W. Mather(5) gives the preference to the employment of mica instead of bone-ashes, as a support in the refinement of silver from lead, since it absorbs less silver. He describes, moreover, his method of determining the weight of the silver globules by microscopical measurement, with regard to which we refer to the treatise.

Gold.—O. Henry(6) has proposed a process for the indirect estimation of gold in the humid way, depending upon the determination of the amount of copper which replaces the gold in solution, when a neutral solution of gold, mixed with an excess of bicarbonate of potassa, is digested at a gentle heat with metallic copper perfectly reduced by hydrogen, till all the gold is precipitated. The determination of the copper in the solution slightly acidified with sulphuric acid, is effected by means of a graduated solution of ferrocyanide of potassium. The resulting numbers given by Henry in support of his method, leave still some grounds for doubt respecting its precision and accuracy, since they contradict themselves as to the amount of copper corresponding to the gold.

Analysis of Ashes.—With regard to the analysis of ashes, whether of vegetal or animal origin, important contributions have been furnished by H. Rose, Heintz and Wackenroder, who endeavoured to overcome and remove the defects of the methods of investigation in use up to the present time, proposed by Will and Fresenius, by Erdmann and by Mitscherlich, of which a synopsis

(1) Compt. Rend. 8 June, 1846.
(2) Compt. Rend. XXVI, 275.
(3) From the Ber. der Freunde der Naturwissensch. zu Wien, IV, in J. Pr. Chem. XLVI, 174.
(4) Arch. Pharm. [2] LVI, 21.
(5) Sill. Am. J. [2] III, 409.
(6) J. Pharm. [3] XI, 5.

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has been given by Knop(1). Erdmann(2) first showed by experiment, that in the preparation of the ashes of plants at a high temperature, the chlorides of the alkali-metals are partly volatilized, the sulphates decomposed, and the bibasic phosphates converted into the tribasic salts. In order to avoid as much as possible these disadvantages H. Rose(3) proposes the following method. The organic substance is carbonized at a low red heat in a capacious platinum or clay crucible, until a strong empyreumatic odour ceases to be perceived, and the carbonaceous mass yields no longer any yellow or brown substance to water. The remaining mass is now exhausted with hot water as long as a few drops of the washings leave any considerable residue. The aqueous solution contains the alkaline salts (chlorides, sulphates, and phosphates), which existed as such in the organic substance, and frequently, likewise, alkaline carbonates which either pre-existed in the substance, or were formed in the process of carbonization. It is evaporated nearly to dryness, diluted with water, allowed to stand for some time in order to separate the earthy salts (carbonates and phosphates of lime and magnesia), which had been dissolved in the salts of the alkalies; the precipitate is then filtered off, the filtrate dried up, weighed, and the acids and bases contained therein estimated by the known methods. —The carbonized mass exhausted with water, is now digested for some time with hydrochloric acid, and then washed with hot water, until a considerable quantity of the washings ceases to be precipitated by ammonia; the acid solution contains the earthy phosphates which were present as such, and sesquioxide of iron; these are precipitated by ammonia, weighed together with the earthy salts deposited from the aqueous solution, and the bases separated from the phosphoric acid according to a presently to be described method of Rose. The liquid filtered from the earthy phosphates still contains some lime and magnesia, which are successively precipitated as oxalate and phosphate.—The carbonized mass exhausted with hydrochloric acid is yet rich in ash; it is, by degrees, completely incinerated in a thin porcelain crucible, through the perforated cover of which oxygen is passed, and the weight of the ashes added to that of the constituents extracted by water and hydrochloric acid. The ashes last obtained contain the same salts as the aqueous or acid solution of the carbonized organic substance, chiefly however, earthy phosphates, and so much the more iron, as more care was taken to exclude the

(1) J. Pr. Chem. XXXVIII, 14.
(2) Ann. Ch. Pharm. LIV, 353.
(3) Pogg. Ann. LXX, 449.

air in the process of carbonization.—Upon the views which H. Rose entertains with regard to the form in which these constituents of the ash are so obstinately retained by the charcoal, that they cannot be extracted by acids, we shall have to report in the next year. Analysis of ashes.

Heintz(1) arrived at the same method as H. Rose, for determining the constituents of the ash. He showed, moreover, that in the case in which the ash contains alkaline carbonates and phosphates, some carbonic acid is lost in consequence of the formation of the tribasic phosphate even at the low temperature employed in the carbonization. According to the experiments of Heintz, pyrophosphate of soda is converted by carbonic acid into acid pyrophosphate and into carbonate of soda, hence the carbonic acid which has been expelled, does not admit of being thus replaced. Heintz attempted, therefore, to determine the quantity of carbonic acid in the following manner; he carbonized a part of the organic substance, and estimated the chlorine in the aqueous solution of the charcoal; another portion was, after carbonization, exhausted with hydrochloric acid, the hydrochloric solution mixed with the ashes of the charcoal, evaporated to dryness, heated to the temperature of carbonization and the chlorine estimated in the residue. The difference between the quantities of chlorine calculated upon 100 parts of organic substance should be equivalent to that quantity of carbonic acid, from which the percentage-amount of salts formed by organic acids with fixed bases is to be deduced. More recent experiments of Heintz, however, have shown, that the amount of carbonic acid, calculated in this way, must always prove inaccurate, because, on the one hand a solution of phosphate of lime in hydrochloric acid, when evaporated and heated, retains a considerable quantity of chlorine; on the other hand, because the chloride of magnesium produced from the carbonate of magnesia existing in the ash, is decomposed by heating, with loss of chlorine. Now, the quantity of carbonic acid might be calculated from that amount of base, which remains uncombined, after the various bases found have been assigned to the acids according to their saturating capacity; but for this purpose it would be necessary, as Heintz justly remarks, that this saturating capacity, or the form in which the constituents of the ash are contained in the organic substance, should be known, a knowledge, which, though we have approached it by recent researches, we have by no means yet attained.—For the estimation of the phosphoric acid, Heintz precipitates the acetic solution of the ash with

(1) Pogg. Ann. LXXII, 113; Berl. Acad. Ber. 1847, 225; J. Pr. Chem. XLII, 139.

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nitrate of lead, decomposes the precipitated combination of proto-chloride and phosphate of lead with sulphuric acid and alcohol, and separates the phosphoric acid from the filtrate by means of ammonia and sulphate of magnesia. His process for the estimation of the alkalies was described in II. p. 226.

Wackenroder(1) prefers to incinerate completely in crucibles (which, in the case of fusible ashes, are lined with potato-starch), or in cylinders of sheet iron which are furnished with a tube, and directs particular attention to cleansing the parts of plants from the earthy substances which they frequently enclose. He considers, from preliminary experiments, the addition of acetate of lime, (or of carbonate or caustic lime), as well calculated to facilitate the incineration of fusible substances rich in silicic or phosphoric acid, and to prevent the formation of cyanides or sulphides. The method followed by him in the quantitative analysis is only applicable to ashes which are rich in lime, in carbonate of potassa and chloride of potassium, or which have been converted into calcareous ashes by the above-mentioned addition. The examination of the ashes is divided into the analysis of the portion soluble in water, and that of the insoluble part.

1. *Portion soluble in water.*—If the calcareous ash contain carbonate of potassa, there will be found in the aqueous solution (Wackenroder employs from 10 to 20 grms. of ash, and from 4 to 6 times its weight of water), all the sulphuric acid and a part of the phosphoric acid, with traces only of silicic acid, lime, and magnesia. The earthy residue consists of the rest of the phosphoric acid, of silicic, and carbonic acid, in combination with lime, magnesia, sesquioxide of iron and alumina, together with proto-sesquioxide of manganese. If the ash be free from carbonate of potassa, the aqueous solution contains chiefly chlorides and sulphates, but no phosphoric acid. In case the aqueous solution becomes turbid upon standing for some time, the precipitate of carbonate, phosphate and silicate of lime is filtered off, and added to the earthy residue(2). If the residue be gently ignited in a closed platinum crucible, and its weight subtracted from that of the ash, a control is obtained for the determination of the total amount of the soluble salts of the ash. The aqueous solution is divided into five parts, differing in quantity according to circumstances. In one portion the silica is estimated

(1) Arch Pharm. [2] LIII, 1.

(2) From many ashes (also from carbonized argol) spirit of wine of 0·835 spec. grav. extracts some caustic potassa.

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by acidifying with hydrochloric acid, heating, adding ammonia, and allowing the mixture to stand for twenty-four hours. The precipitate of silica, which is always very slight, may also contain traces of earthy phosphates. In the second portion the lime and magnesia are determined; in the third the chlorine (and cyanogen) according to the known methods. The fourth part, somewhat greater than the others, serves for the estimation of the sulphuric acid, phosphoric acid, and carbonic acid. It is heated, and when cold, entirely precipitated with chloride of barium, and the washed sulphate, phosphate, and carbonate of baryta weighed after gentle ignition. When treated with hydrochloric acid, the sulphate of baryta remains; from the filtrate ammonia precipitates the phosphate of baryta ($3\,BaO, PO_5$)(1). The amount of carbonate of baryta (and consequently of carbonic acid) is obtained from the diffcrence. The amount of the potassa (soda was found only once, in beet-root ashes in very small quantity, not even $\frac{1}{100}$th part of the potassa) Wackenroder determines, either as bitartrate of potassa, by precipitating the sufficiently evaporated solution with tartaric acid, washing the precipitate (containing 25 per cent of potassa) with a little cold water, and drying at 100^0, or, as usual, in the form of the platinum-salt, or lastly, when soda is present, by indirect analysis, as sulphate.

2. *Portion insoluble in water.*—The portion of the ash which is insoluble in water is treated with hydrochloric acid, the silicic acid (together with the sand and charcoal) filtered off, and the sulphuric acid, if present, determined first in the filtrate; this solution is then, after the excess of baryta has been previously separated by sulphuric acid, nearly neutralized with carbonate of soda, mixed with acetate of soda and boiled, when the total amount of sesquioxide of iron and of alumina are precipitated as phosphates(2). They are dissolved in hydrochloric acid, after having been ignited and weighed as $Fe_2 O_3, PO_5$ and $Al_2 O_3, PO_5$. The solution is then heated with an excess of concentrated soda, and the amount of the separated sesquioxide of iron estimated; the alkaline liquid yields, when acidified with acetic acid and boiled, the phosphate of alumina which is

(1) Comp., however, also I. p. 258 upon this point.

(2) According to the statement of Wackenroder and Ludwig the phosphate of sesquioxide of iron precipitated under these circumstances has always a composition expressed by the formula $Fe_2 O_3, PO_5 + 4\,HO$; the phosphate of alumina (ignited) has the corresponding formula $Al_2 O_3, PO_5$.

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washed with dilute spirit, and weighed as $Al_2 O_3$, PO_5(1). For the determination of the rest of the phosphoric acid, Wackenroder mixes the solution filtered from this precipitate, with solution of sesquichloride of iron of known strength, the iron amounting to about $\frac{1}{20}$ or $\frac{1}{10}$ of the ash, then with a sufficient quantity of acetate of soda and boils, when all the phosphoric acid is precipitated in combination with the sesquioxide of iron. By subtracting from the weight of this precipitate that of the sesquioxide of iron, the amount of which is known, we obtain that of the phosphoric acid(2).—The lime and magnesia, which are contained, together with the manganese, in the solution filtered from the phosphate of sesquioxide of iron, are estimated by the usual methods; for the estimation of the manganese, Wackenroder first precipitates the hot solution with excess of carbonate of soda, gently ignites the precipitate, and then treats it with a very slight excess of exceedingly dilute nitric acid, which leaves undissolved all the manganese as proto-sesquioxide; the filtrate contains the lime and magnesia.

Analysis of Arable Soils.—H. Reinsch(3) has communicated a "simplified method of analysing soils and sub-soils." It may be sufficient if we mention, with regard to this process, that the amount of potassa is estimated from the weight of the precipitate produced by tartaric acid in the evaporated hydrochloric solution, after that in this liquid (containing sesquioxide of iron, alumina, lime, and magnesia) the sesquioxide of iron had been estimated according to the method of Fuchs, by means of metallic copper.

Organic Matter in Water.—In order to ascertain the presence of a considerable quantity of dissolved organic matter in river- or well-

(1) For the separation of phosphoric acid from its combinations with sesquioxide of iron and alumina, Wackenroder decomposes the hydrochloric solution of the precipitate, by means of concentrated soda with the aid of heat, and mixes the alkaline solution, containing the total amount of phosphoric acid and alumina, first with chloride of barium or baryta-water, as long as a precipitate (of phosphate, carbonate and sulphate of baryta) is produced, then with more soda, heats to ebullition and filters. From the filtrate the alumina is obtained by precipitating with sal-ammoniac, or by neutralizing with sulphuric acid, and adding carbonate of ammonia. The baryta precipitate is treated with hydrochloric acid, and the filtrate mixed with ammonia which precipitates phosphate of baryta $3\,BaO, PO_5$; (comp. I. p. 258). Wackenroder remarks that about $\frac{1}{20}$th of phosphate of alumina remained mixed with the phosphate of baryta unless the solution of caustic soda employed was sufficiently concentrated. Hermann (J. Pr. Chem. XL, 32) and Frescnius (II. p. 215) have published similar methods of separation.

(2) In the same way Wackenroder estimates arsenic acid.

(3) Jahrb. Pr. Pharm. XVII, 152.

water, Dupasquier(1) mixes about 25 or 30 grms. of it with so much terchloride of gold that the liquid appears yellowish, and heats to ebullition. If the water contain only the ordinary quantity of organic matter, it remains somewhat yellow, even when boiled for some time; but if the quantity present exceed that usually observed, the water becomes, from the reduction of the gold, first brown, and afterwards violet-blue. Organic matter in water.

Discrimination between Cane- and Grape-Sugar.—Guibourt(2) has given a synopsis of the methods usually employed up to the present time for the discrimination between cane- and grape-sugar. These methods have recently acquired so much the more importance as the adulteration of cane-sugar, or of the syrups prepared from it, with grape-sugar or its syrup have become more frequent. There are essentially only two methods; they depend upon the behaviour of the sugar towards protoxide of copper in presence of an alkali, or towards caustic alkalies alone.

1. At the common temperature or at a boiling heat, cane-sugar produces the reduction of the protoxide of copper, in presence of a free alkali, either not at all or only very slowly, whilst by grape-sugar a precipitate of suboxide of copper is thrown down (Trommer), after a few hours in the cold, and immediately on boiling. Upon this deportment Barreswill(3) has based the quantitative estimation of grape-sugar by employing a graduated test-solution of tartrate of copper and potassa.

2. Cane-sugar may be mixed with caustic alkalies without any perceptible change of colour, whilst grape-sugar is decomposed with production of a deep brown tint. Pésier, Kuhlmann, Chevallier, and Mialhe have applied this reaction to the detection, and Péligot(4) even to the quantitative determination of grape- or fruit-sugar. When honey is adulterated with starch-sugar, it may be recognized, according to Guibourt, not only by its physical properties, but also by the amount of sulphate of lime contained in it, which always accompanies the starch-sugar prepared with sulphuric acid. Unadulterated honey is free from lime-salts, but if it be filtered through paper, which has not been washed with hydrochloric acid, it acquires traces of lime from it; for this reason, we must confine ourselves to the test for sulphuric acid. Honey, with which $\frac{1}{4}$ or $\frac{1}{5}$ of starch-sugar is

(1) Compt. Rend. XXIV 626; J. Pharm. [3] XIII, 164.
(2) J. Pharm. [3] XIII, 263.
(3) J. Pharm. [3] VI, 301; Berzelius' Jahresber. XXV, 556.
(4) Compt. Rend. XXII, 936; Berzelius' Jahresber. XXVII, 388.

Discrimination between cane- and grape-sugar.

mixed, gives a very considerable turbidity with salts of baryta. Dextrin retained by the starch-sugar, is precipitated together with gypsum, on addition of strong alcohol.

Reich(1) has found several other methods of distinguishing cane- and grape-sugar in their behaviour with concentrated sulphuric acid, with chromic acid and with nitrate of protoxide of cobalt and potassa. Grape-sugar produces with concentrated sulphuric acid, the sulpho-saccharic acid of Péligot, which does not precipitate baryta-salts, whereas cane-sugar, its syrup, or uncrystallizable sugar is destroyed by sulphuric acid, without formation of sulpho-saccharic acid. For the detection of grape-sugar in cane-sugar, the syrup, concentrated as far as possible in a water-bath, is mixed gradually, too much heat being avoided, with concentrated sulphuric acid in slight excess, diluted, after half an hour, with 20 parts of water, and saturated with carbonate of baryta. If the filtered liquid gives any precipitate of sulphate of baryta upon addition of dilute sulphuric acid, sulpho-saccharic acid, arising from the grape-sugar, was present. Herzog(2) found, even in employing the purest cane-sugar, that the liquid filtered from the sulphate and excess of carbonate of baryta, always contained baryta, in consequence of the formation of formiate and acetate of baryta, which renders this method as uncertain as those in use up to the present time.—The employment of bichromate of potassa presents, on the other hand—also according to Herzog's experiments—more certainty. If syrup of cane-sugar be heated to ebullition with a hot-saturated solution of this salt, a green liquid is produced, the sugar being rapidly oxidized. Grape-sugar and syrup of grape-sugar are not affected under the same circumstances. If syrup of cane-sugar be mixed with $\frac{1}{3}$, $\frac{1}{4}$, or only $\frac{1}{8}$ of syrup of grape-sugar, the latter prevents the reaction, and the change of colour is not produced; even when a still smaller quantity of grape-sugar is present, there appears, by no means the pure, dark-green colour, but a brownish-yellow or brownish-green tint.—When, according to Reich, a concentrated solution of pure cane-sugar is heated to ebullition with some fused caustic potassa, and nitrate of cobalt added to it, a blue precipitate is obtained, whereas grape-sugar under the same circumstances, even though it be mixed with cane-sugar, prevents the precipitation of the cobalt-salt, when in a dilute state, and causes the formation of a dirty brown precipitate in concentrated

(1) Arch. Pharm. [2] L, 293; J. Pr. Chem. XLIII, 70; Repert. Pharm. [3] XLVIII, 122; J. Pharm. [3] XIV, 79.

(2) Arch. Pharm. [2] L, 299.

solutions. Reich considers this a certain method of detecting grape-sugar when mixed with cane-sugar. Herzog observed, that diabetic-sugar and milk-sugar comport themselves like grape-sugar; mannite, on the contrary, like cane-sugar, towards caustic potassa and nitrate of protoxide of cobalt.

Discrimination between cane- and grape-sugar.

Acetic Acid.—Riegel(1) believes that he substitutes a more accurate method for those at present employed for the determination of the amount of acid in vinegar, by ascertaining the increase of weight which the vinegar suffers after neutralization with hydrate of baryta and filtration from the insoluble baryta-compounds thus produced. The increase in weight of the vinegar brought to its original volume he considers as baryta, and calculates there from the amount of acetic acid which it represents, without taking into consideration the insoluble baryta-compounds which were filtered off, though they were weighed with the vinegar originally employed.

Lactic Acid.—Strecker(2) has pointed out that the behaviour of lactate of copper towards an excess of lime, described by Pélouze(3), and used by that chemist as well as by Boussingault(4) and Gobley(5) as a characteristic test for lactic acid, cannot be employed with safety for the detection of this acid. He has shown that lactic acid certainly retards the precipitation of protoxide of copper by milk of lime, but does not prevent it, and that even in the presence of salts of acetic, citric, malic and tartaric acids, this oxide is entirely separated by milk of lime, and that, on the other hand, some copper remains in solution, when gelatin, glycocoll, impure lactate of lime, chloride of ammonium, cane-sugar, grape-sugar, gelatin boiled with potassa, fibrin, albumin, or casein is present.

Hydrocyanic Acid.—The behaviour of the higher sulphides of ammonium towards hydrocyanic acid, furnishes, according to Liebig(6), a delicate reaction for this acid. A couple of drops of an acid, which is diluted with so much water that it ceases to give any certain reaction with iron-salts by the production of prussian blue, heated with a drop of sulphide of ammonium on a watch-glass until the mixture is colourless, yields a solution of sulphocyanide of ammonium, which gives a very dark blood-red colour with salts of sesqui-

(1) Arch. Pharm. [2] LV, 167.
(2) Ann. Ch. Pharm. LXI, 316.
(3) Ann. Ch. Phys. [3] XII, 267; Ann. Ch. Pharm. LIII, 124.
(4) Ann. Ch. Phys. [3] XV, 97.
(5) Berzelius' Jahresber. XXVI, 917.
(6) Ann. Ch. Pharm. LXI, 127; Phil. Mag. [3] XXXI, 140.

Hydrocyanic acid.

oxide of iron, and a white precipitate of subsulphocyanide of copper, with copper-salts in the presence of sulphurous acid.

A. Taylor(1) has tested the method as to its delicacy, and found that we may in this way distinctly recognize in a very dilute solution $\frac{1}{3930}$ grn. of anhydrous hydrocyanic acid, whilst $\frac{1}{786}$ grn. can no longer be detected by the formation of prussian-blue. He proposes to place the liquid containing hydrocyanic acid in a watch-glass, and to cover this with another moistened with a drop of sulphide of ammonium. After a few minutes the upper watch-glass is gently heated till the sulphide of ammonium is volatilized, and then sesquichloride of iron added to the dry residue. In this manner Taylor recognized $\frac{1}{17}$ grn. of anhydrous hydrocyanic acid in the contents of a stomach which had undergone putrefaction, and in which, on account of the sulphuretted hydrogen it contained, the reaction with nitrate of silver, previously described by him and applied in a similar manner, could not be used(2).

Sulphate of Cinchonine in Sulphate of Quinine.—The cinchonine-salt, which serves to adulterate the sulphate of quinine, is usually introduced into the middle of the bottles containing the former. Henry(3) directs for its detection, to dissolve from 20 to 30 grms. of the suspected salt in slightly acid water, to pour the solution into an excess of solution of soda, and to dissolve the washed precipitate in acetic acid. The acetate of quinine is now crystallized out by repeated evaporation, the mother-liquor again mixed with caustic soda, the precipitate treated first with ether, then repeatedly with hot alcohol, which, on evaporation, leaves the cinchonine in the crystalline state.—If the quinine-salt be mixed with crystallized cinchonine, the mixture is not soluble in 10 parts of hot water.

Strychnine.—E. Marchand(4) still considers the method published by him in 1843 for the detection of strychnine(5)—according to which, the substance, after having been mixed with binoxide of

(1) Ann. Ch. Pharm. LXV, 263.

(2) Reinach has, under Will's direction, performed several experiments, which likewise point out the delicacy of this reaction. A rabbit was poisoned with hydrocyanic acid, in such a manner that it was obliged to inhale the vapour. In the blood, the brain and the urine, after distilling these matters with tartaric acid, the presence of hydrocyanic acid was easily shown by means of sulphide of ammonium and sesquichloride of iron, whilst the usual reaction (production of prussian blue) gave no result. The contents of the stomach were free from hydrocyanic acid.

(3) J. Chim. Méd. [3] IV, 258; J. Pharm. [3] XIII, 107; J. Pr. Chem. XLIV, 249.

(4) J. Pharm. [3] XIII, 251; J. Pr. Chem. XLIV, 185; Chem. Gaz. 1848, 187.

(5) J. Pharm. [3] IV, 200; Berzelius' Jahresber. XXIV, 400.

lead and concentrated sulphuric acid containing 1 per cent of nitric acid, becomes first blue, then violet, red, and lastly canary-yellow—certain, since by the omission of the nitric acid or by the employment as the most of binoxide of manganese or bichromate of potassa instead of peroxide of lead, the characteristic succession of the changes of colour is prevented. tr ychnine

With regard to the quantitative determination of nicotine in tobacco, comp. I. p. 472, and respecting the microscopic detection of several organic bases, I. p. 515.

Estimation of Urea.—Urea, in aqueous solution, is very easily decomposed into carbonate of ammonia, if heated above 100° in a vessel hermetically sealed. At 120° the change proceeds slowly, at 220° or 240° it is, however, completed in from three to four hours. If the liquids are heated in the presence of an ammoniacal solution of chloride of barium, a quantity of carbonate of baryta is obtained which represents the amount of urea present. Upon this reaction Bunsen(1) bases the following very simple, accurate, and expeditious method for the estimation of urea in urine.—About 50 or 60 grms. of urine are weighed in a flask, which has been dried or rinsed with the liquid to be examined, and the border of which is slightly greased; the greater part of it is poured into another flask, and the weight of this portion A determined by again weighing the partly emptied flask. The urine weighed off in this manner is precipitated with a very concentrated solution of chloride of barium containing some free ammonia, and the weight of the baryta-solution B, added to it, determined in the same way. As soon as the precipitate has, after agitation of the closed flask, subsided, the supernatant fluid is poured upon a weighed, but not moistened filter, and about 25 or 30 grms. of it are allowed to flow through a long-necked funnel drawn out to a point, into a strong weighed glass tube, closed by fusion at the lower end, containing about 3 grms. of solid chemically pure chloride of barium; great care being taken, by using the long-necked funnel, to avoid moistening the walls of the tube above the level of the liquid. After the weight of the liquid C, filtered into the tube, is ascertained by a second weighing of the latter, the tube is sealed by fusion at about 1 or 1½ inch above the level of the liquid, in which operation care should be taken to thicken the glass sufficiently. The baryta-precipitate is meanwhile thrown completely upon the weighed filter, washed, and its weight b determined. The heat necessary for the metamorphosis of the urea is best obtained in a copper oil-bath,

(1) Ann. Ch. Pharm. LXV, 375; J. Pharm. [3] XVI, 151.

Estimation of urea.

heated by a lamp and traversed by copper tubes closed at one end for the reception of the sealed glass tubes. If glass tubes, of 2·5 millimetres thickness, be employed, the internal diameter of which does not exceed 15 millimetres, there is no explosion to be feared at a temperature of 220° or 240°; moreover, such explosion would be entirely harmless if the mouths of the tubes or the door of the oil-bath were turned from the experimenter. After three or four hours' heating, the oil-bath is allowed to cool, and the tubes are cut with a file and opened by means of a hot piece of charcoal; the separated crystals of carbonate of baryta are now collected on a small filter, and washed with water free from carbonic acid, before their weight K is determined. If the values found for the weights A, B, C, b, K, be substituted in the formula $H = \frac{30{\cdot}41\ K\ (A+B-b)}{A\ C}$, H will give the percentage-amount of urea in the urine examined.

Bunsen has convinced himself, by numerous experiments performed with great circumspection, that all the normal constituents of urine, the so-called extractive matters of the urine, as well as hippuric, benzoic, and uric acids exert no influence whatever upon the estimation of urea. Uric acid, indeed, suffers, under the same circumstances, a metamorphosis which gives likewise rise to the formation of carbonate of ammonia; but this acid is so completely precipitated by chloride of barium and ammonia, that its presence does not interfere with the result. Bunsen has also satisfied himself that even other easily decomposable animal substances, such as milk, white of egg, serum of blood, fibrin, sinews, fat, saliva, mucus, as well as diabetic sugar, chloride of sodium, sulphate of soda, and phosphate of ammonia exert no injurious influence upon the determination of urea. The only unavoidable source of error is caused by the creatin contained in urine. This substance is decomposed, as Bunsen has likewise proved by experiment, into hydrochlorate of ammonia and sarcosine, and carbonate of baryta. But the amount of creatin in the urine is so small, that the error thereby introduced is of no consequence, particularly as it counter-balances, to a certain extent, the inaccuracy arising from the solubility of the carbonate of baryta.

Heintz has shown(1) that the amount of creatin contained in urine causes no perceptible error in the estimation of urea according to the method previously(2) described by him, and which agrees

(1) J. Pr. Chem. XLII, 401. (2) Pogg. Ann. LXVI, 114.

essentially with that of Ragsky(1); his experiments gave at most $\frac{1}{20000}$ of urea in excess. Estimation of urea.

According to a preliminary communication of Millon(2), urea may be determined with great accuracy by collecting in a potassa-apparatus, and then weighing the carbonic acid evolved when nitrite of suboxide of mercury, dissolved in nitric acid, acts upon the urine, in which case the urea is decomposed into carbonic acid and nitrogen, whilst the other constituents of the urine suffer no alteration. If the weight of the carbonic acid be multiplied by 1·371, it gives the weight of the urea. Millon promises a more detailed account of his process. (With regard to the estimations of urea performed by Millon, comp. II. p. 197).

Uric Acid.—Heintz(3) has ascertained, by experiment, that uric acid may be determined by simple precipitation with an acid, both in normal urine and in the presence of grape-sugar, of albumin, or of the soluble constituents of blood. If albumin be present, acetic or phosphoric acid is employed, in all other cases hydrochloric acid perfectly answers the purpose. The loss occasioned by the slight solubility of uric acid, amounts to about 0·09 in a thousand parts of the urine employed; it is not increased by the presence of grape-sugar, albumin, or of the soluble blood-constituents, but is in all these cases fully compensated for by a colouring matter, which is precipitated with the uric acid. Bile contained in urine is capable of giving rise to a greater loss of uric acid, though never exceeding 0·25 in a thousand parts of urine.

Bile.—Heintz(4) remarks, that the change of colour sometimes produced—for it does not appear always—by nitric acid in liquids containing bile (first green, then blue, violet, red, and lastly yellow) is occasioned only by the colouring matter which Berzelius(5) has named cholepyrrhin, and not by the essential constituents of the bile, and can therefore be regarded only as a test for the presence of this substance.

Chloroform. Determination in Blood.—The vapour of chloroform, when exposed to a red heat, is decomposed into charcoal, hydrochloric acid and chlorine. This deportment is used by Ragsky(6)

(1) Ann. Ch. Pharm. LVI, 29; Berzelius' Jahresber. XXVI, 858.
(2) Compt. Rend. XXVI, 119.
(3) Pogg. Ann. LXX, 122; J. Pr. Chem. XL, 319.
(4) Pogg. Ann. LXX, 136.
(5) Berzelius' Jahresber. XXII, 562.
(6) From Ber. über Mitth. von Freunden der Naturwissensch. in Wien III, 482, in J. Pr. Chem. XLVI, 170; Arch. Pharm. [2] LVI, 74.

Chloroform. Determination in blood.

in determining the presence of this substance in blood. An ounce of blood, as drawn from the organism, is introduced into a flask, provided by means of a perforated cork with a tube bent at right angles, whose horizontal limb is slightly drawn out. This limb is now ignited, a paper covered with a mixture of starch and iodide of potassium being placed into the extremity of the tube, while the flask is heated in a water-bath. The chloroform evolved is decomposed by the red-hot glass tube, and the chlorine which is liberated imparts a blue colour to the paper by acting on the iodide of potassium. Ragsky succeeded by this method in distinctly proving the presence of $\frac{1}{100000}$ of chloroform in blood.

Recognition of Blood-Stains.—According to Piria(1) the textures of flax and hemp are dissolved by concentrated sulphuric acid, while the fibrin of a blood-stain adhering to it, is not altered, but forms a sort of net-work, on which the impressions of the texture may be traced.

Fibrin.—Chatin and Bouvier(2) propose for the separation of the fibrin from the human blood, which sometimes is attended with difficulties, to add to the latter a known quantity of the blood of one of the larger mammalia, in which the amount of fibrin is ascertained by a second experiment. They state that in this manner the fibrin can be separated more completely by beating.

APPENDIX TO ANALYTICAL CHEMISTRY.

Rain-water.—According to R. A. Smith(3), rain-water falling in towns contains organic matter, exceeding usually 0·001 per cent (in Manchester ?). Rain-water collected after thirty hours' rain, was found to contain 0·0027 per cent of chlorine and 0·00343 of sulphuric acid. Smith frequently found the rain water alkaline, which he thinks is due to carbonate of ammonia, and the air frequently acid.—Water from peaty soil contains a substance, which on burning evolves the odour of peat; the river Dee, near Chester, contains 25 grains of such organic matter per gallon. River-water in the neighbourhood of large towns leaves a residue, which on burn-

(1) J. Chim. Méd. [3] IV, 163.
(2) J. Chim. Méd. [3] IV, 145.
(3) Phil. Mag. [3] XXX, 478 ; Chem. Soc. Mem. III, 311.

ing evolves the odour of protein-compounds in a state of decomposition. In well-water at Manchester Smith found as much as 14 grains of organic matter and ammonia-salts, and 70 grains of nitrates per gallon.

Well-Water and River-Water. In Germany and Denmark.—Ragsky has examined the water of two Artesian Wells in *Vienna*, *A*(1) of that near the Mariahilf line, and *B*(2) of that at the station of the Vienna-Raab Railway. Column *C* gives an abstract of Johnstrug's(3) analyses of the Copenhagen well-water. *A* represents the quantities in Vienna grains referred to 16 ounces of water; in *B* or *C* the quantities are referred to 1000 parts of water.

	A	*B*	*C*
Carbonate of lime	2·800	0·0078	2·68 to 5·13
„ „ magnesia	0·694	0·0043	0·19 „ 0·61
„ „ soda	—	0·6387	—
„ „ protoxide of iron	0·010	0·0010	—
Chloride of potassium	—	—	0·51 „ 7·21
„ sodium	—	0·2893	
„ calcium	0·099	—	—
„ magnesium	1·553	—	0·26 „ 0·75
Sulphate of potassa	—	—	0 „ 0·75
„ lime	1·979	—	0·09 „ 0·88
„ magnesia	—	—	0 „ 0·75
Nitrate of soda with some potassa	0·977	—	—
„ „ „ magnesia	1·155	—	—
Phosphate of lime	—	—	0·07 „ 0·39
Silicic acid	0·132	0·0122	0·18 „ 0·31
Loss and organic substance	0·146	0·0237	—
Volatile compounds	—	—	0 „ 0·60
Free carbonic acid	2·180	—	—

In the Netherlands.—Müller(4) has analysed the water of the river *Meuse*, of several wells in *Rotterdam*, of the *North Sea* at *Scheveningen*, and of the *Rhine* near *Emmerich*. He gives the amount of fixed constituents for 2 lbs., without stating what sort of lbs. he adopted, and in what units the various weights are expressed. We consequently refrain from details.—Kane's analyses of the water of the *Lys*, *&c.*, are enumerated in our Report on Technical Chemistry.

In France.—Boutron-Charlard and O. Henry(5) have examined

(1) Berichte von Freunden der Naturwissensch. in Wien III, 90; J. Pr. Chem. XLVI, 220.

(2) Berichte von Freunden der Naturwissensch. in Wien II, 121.

(3) From Arch. for Ph. og Techn. Ch. in Jahrb. Pr. Pharm. XVII, 286.

(4) Arch. Pharm. [2] XLIX, 10.

(5) J. Pharm. [3] XIV, 161.

In France. the various waters which feed the public wells of *Paris*. This investigation embraces specimens of *Seine*-water collected at the *Pont d'Ivry* (A), at the *Pont Notre-Dame* (B), at the *Pompe du Gros-Caillou* (C), at the *Pompe de Chaillot* (D); the water of the *Marne* (E), the water coming from *Arcueil*(1) (F); the water of the Artesian Well at *Grenelle* (G), the water of the *Canal de l'Ourcq* (H). The table gives the number of grammes of solid constituents, and the number of litres of gas contained in 1 litre of water.

	A	B	C	D	E	F	G	H
Bicarbonate of lime	0·132	0·174	0·22	0·230	0·301	0·158	0·0292	0·158
,, ,, magnesia	0·060	0·062	0·07	0·076	0·120	0·060	0·0092	0·075
,, ,, potassa	—	—	—	—	—	trace	0·0100	—
Sulphate of lime	0 020	0·039	0·04	0·040	0·022	0·138	—	0·080
,, ,, magnesia	0·010	0·017	0·027	0·030	0·018	0·072	—	0·095
,, ,, soda							0·0320	
,, ,, potassa	—	—	—	—	—	—		—
Chloride of calcium								
,, ,, magnesium	0·010	0·025	0·032	0·032	0·020	0·081	—	0·113
,, ,, sodium							0·0570	
,, ,, potassium								—
Potassa-salts	trace	trace	trace	trace	—	—	—	—
Alkaline nitrates	trace	trace	trace	trace	trace	trace	—	trace
Silicic acid							0·0100	
Alumina	0·008	0·014	0·023	0·024	0·030	0·018	0·0020	0·069
Sesquioxide of iron								
Organic matter	trace	trace	trace	trace	trace	trace	trace	trace
Total amount of the fixed constituents	0·240	0·331	0·426	0·432	0·511	0·527	0·1494	0·590
Atmospheric air	0·003	0·003	0·004	0·003	trace	0·004	—	—
Free carbonic acid	0·013	0·014	0·014	0·013	0·013	0 070	—	—

Deville(2) has examined the composition of the following waters: of the *Garonne*, near Toulouse (A), of the *Seine*, near Bercy (B), of the *Rhine*, near Strasburg (C), of the *Loire*, near Orleans (D), of the *Rhone*, near Geneva (E), of the *Doubs*, near Rivotte (F), of the well-water of Mouillière (G), Billecul (H), Arcier (I), and Bregille (K), near *Besançon*, of Suzon (L), near *Dijon*, and of *Arcueil* (M), near Paris; of the well-water in the Grand'Rue (N), the Rue de la Préfecture (O), and near the Faculté des Sciences (P), at *Besançon*. He determined not only the composition of the whole water, but also that of the precipitate produced by one hour's ebullition, and of the

(1) Respecting the deposit of the water we refer to II, p. 267.

(2) Ann. Ch. Phys. [3] XXIII, 32; Arch. Pharm. [2] LV, 801 (in abstr.)

In France.

soluble and insoluble portion of the residue, left on evaporation. We here give his result respecting the composition of the water as a whole. The following table represents in milligrammes the amount of fixed constituents, and in cubic centimetres that of the free gases (assumed to be dry, of a temperature of 0^0 and a pressure of 760^{mm}) contained in 10 litres of water. The same holds good for Grange's analysis of the water of the *Isère*, near Grenoble (Q)(1). Grange(2) has examined, moreover, the water of several brooks of the Isère-valley. He gives the composition of these brooks which run over soils of varying composition in various stages of their course and discusses the dependence of the amount of fixed constituents on the geological formation of the soil; he adduces the presence of magnesia-salts in water, as the cause of goitre and rickets, &c. For details we refer to the memoir itself.

	A	B	C	D	E	F	G	H
Silicic Acid	401	244	488	406	238	159	250	246
Alumina	—	5	25	71	39	21	43	43
Sesquioxide of iron	31	25	58	55	—	30	—	—
Carbonate of lime	645	1655	1356	481	789	1910	2573	2561
„ „ magnesia	34	27	50	61	49	23	—	46
„ „ protoxide of manganese	30	—	—	—	—	—	—	—
Sulphate of lime	—	269	147	—	466	—	51	100
„ „ magnesia	—	—	—	—	63	—	—	—
Chloride of calcium	—	—	—	—	—	—	7	71
„ „ magnesium	—	—	—	—	—	5	20	40
„ „ sodium	32	123	20	48	17	23	—	—
Sesquicarbonate of soda	65	—	—	—	—	—	—	—
Carbonate of soda	—	—	—	146	—	—	—	—
Sulphate of soda	53	—	135	34	74	51	—	—
„ „ potassa	76	50	—	—	—	—	—	—
Nitrate of potassa	—	—	38	—	40	41	23	44
„ „ soda	—	94	—	—	45	39	118	156
„ „ magnesia	—	52	—	—	—	—	—	—
Silicate of potassa	—	—	—	44	—	—	—	—
Total amount of fixed constituents	1367	2544	2317	1346	1820	2302	3085	3307
Free carbonic acid	170	162	76	18	79	178	390	267
„ nitrogen	79	120	159	202	184	182	154	101
„ oxygen	157	39	74		84	95	64	49

(1) Ann. Ch. Phys. [3] XXIV, 496.
(2) Ann. Ch. Phys. [3] XXIV, 464 complete. Compt. Rend. XXVII, 358 (in abstr.)

In France.

	I.	K.	L.	M.	N.	O.	P.	Q.
Silicic acid	390	348	152	306	314	297	551	37
Alumina	90	65	10	53	94	62	39	35
Sesquioxide of iron	2139	2079	2300	1990	2156	2017	2331	1037
Carbonate of lime	78	43	38	82	85	207	76	25
„ „ magnesia	—	74	—	1638	802	663	2660	208
Sulphate of lime	—	—	—	—	—	—	—	302
„ „ magnesia	—	11	—	—	—	238	199	—
Chloride of calcium	—	27	—	166	72	255	615	7
„ „ magnesium	20	—	32	376	557	15	—	36
„ „ sodium	69	—	21	—	—	—	—	—
Carbonate of soda	45	—	27	54	—	—	—	} 90
Sulphate of soda	—	—	—	201	57	—	—	
„ „ potassa	trace	23	27	—	899	786	535	—
Nitrate of potassa	—	48	—	—	304	870	1229	—
„ „ soda	—	—	—	570	—	—	—	—
„ „ magnesia	—	81	—	—	—	—	381	—
Total amount of fixed constituents	2831	2799	2607	5436	5340	5410	8616	1876
Free carbonic acid	208	226	237	256	202	263	350	110
„ nitrogen	153	142	167	127	171	157	202	} 30
„ oxygen	59	72	75	50	43	41	44	

In England.—Clark(1) has examined the *Thames*-water near *Twickenham*; Abel and Rowney(2) that of the Artesian well in Trafalgar Square, in *London*, which comes from a depth of 400 feet, and is remarkable for its softness (B). In the following table we give the quantity of fixed constituents expressed in grains and in grammes, the amount of free carbonic acid, expressed in English cubic inches and in cubic centimetres, contained respectively in an imperial gallon and in 10,000 grammes of water. In the analysis of a well-water of *Wolverton* (C), by Giles(3), and of the river *Exe*, near Exeter, by Thornton J. Herapath(4) (D) the quantities are expressed in grains and referred to 1 gallon (70,000 grains). For Smith's statements respecting the *Manchester* water, we refer to II. p. 250.

(1) Chem. Soc. Qu. J. I, 155.
(2) Ibid. 97.
(3) Pharm. J. Trans. VIII, 75.
(4) Chem. Gaz. 1848, 429.

In England.

	A.		B.		C.	D.
	In grains.	In grammes.	In grains.	In grammes.		
Spec. grav.	1·0003	—	1·00009	—	1·00067	—
Sulphate of magnesia	—	—	—	—	—	0·160
„ „ potassa	0.66794	0·09542	13.6710	1·95300	—	—
„ „ soda	2·00011	0·28573	8·7493	1·24990	14·324	0·080
„ „ lime	0·45073	0·06439	—	—	—	3·040
Chloride of magnesium	—	—	—	—	—	0·640
„ „ calcium	1·75021	0·25003	—	—	—	trace
„ „ sodium	—	—	20·0585	2·86550	6·003	4·240
Carbonate of lime	12·75946	1·82278	3·2550	0·46500	10·960	0·896
„ „ magnesia	1·02711	0·14673	2·2540	0·32200	2·319	0·064
„ „ soda	—	—	18·0488	2·57840	6·576	—
Nitrate of lime	—	—	—	—	—	0·160
Phosphoric acid	—	trace	—	—	—	—
Phosphate of soda	—	—	0·2910	0·04160	—	—
„ „ lime	—	—	0·0340	0·00486	—	trace
„ „ iron	—	—	—	—	0·540	—
Crenate of magnesia	—	—	—	—	—	trace
Crenic acid	—	—	0·1372	0·01960	—	—
Apocrenic acid	—	—	0·0987	0·01410	—	—
Organic matter	3·48019	0·49717	0·6720	0·09600	2·850	1·600
Sesquioxide of iron	—	trace	—	—	—	—
Alumina	—	trace	—	—	0·260	—
Silicic acid	0·27314	0·03902	0·9710	0·13100	0·200	trace
Loss	0·97106	0·01158	1·1644	0·17404	—	—
Total amount of fixed constituents	22·42995	3·21285	69·4050	9·91500	44·032	10·880
Free carbonic acid	14·233 cub. in.	513·4	8·423 cub. in.	303·9	—	—

In North-America.—Bull(1) has examined the waters remarkable for their hardness, of various wells at Hartford, in Connecticut, in North America. He found in 10,000 parts by weight of water:

	A.	B.	C.	D.	E.
Spec. grav.	1·0008	1·0004	1·0001	1·0008	1·0011
Sulphate of lime	0 69	0·61	0·30	0·79	0·89
Chloride of magnesium	0·41	0·23	0·22	0·81	0 41
„ „ calcium	1·12	0·70	0·39	—	1·79
„ „ sodium	1·91	—	—	—	2·67
Carbonate of lime	2·25	1·31	0·21	1·48	—
„ „ magnesia	0·19	—	—	—	1·51
Crenate of magnesia	—	0·13	0·76	0·44	—
Carb. of soda, equivalent to crenate	0·22	1·09	1·19	2·35	2·67
Sesquioxide of iron	0·04	0·38	—	0·04	trace
Alumina			0·14		
Lime	—	—	—	0·23	—
Silicic acid	0·18	0·60	0·14	0·04	0·10
Loss	0·10	0·46	—	0·18	1·78
Total amount of fixed constituents	7·11	5·51	3·31	6·36	11·82

(1) Sill. Am. J. [2] IV, 385.

Sea-water.

Sea-water.—Calamai(1) has made an analysis of the water in the laguni at Venice (A. spec. grav. 1·0184) and in the port of Leghorn (B. spec. grav. 1·0231). Usiglio(2) has examined the water of the Mediterranean taken in the neighbourhood of Cette (at a distance of from 3000 to 5000 metres from shore, and at a depth of 1 metre; C. spec. grav. 1·0258). In these analyses the composition refers to 10,000 parts by weight of water. In Figuier and Mialhe's(3) analysis of sea-water, taken at a distance of some leagues from the coast of Havre (D), the quantities are represented in grammes and referred to 10 litres. The latter was found to contain traces of sesquioxide of iron and manganese, of carbonate and phosphate of magnesia.

	A.	B.	C.	D.
Sesquioxide of iron	—	—	0·13	trace
Carbonate of lime	—	—	1·14	1·32
Sulphate of lime	6·020	8·940	13·57	12·10
„ „ magnesia	27·500	30·900	24·77	24·62
„ „ potassa	—	—	—	0·94
Bromide of magnesium	—	—	—	0·30
Chloride of magnesium	25·910	30·260	32·19	29·05
Chloride of potassium	8·330	11·111	505	—
Bromide of sodium	—	—	5·56	1·03
Chloride of sodium	223·459	261·908	294·24	257·04
Silicate of soda	—	—	—	0·17
Sum total	291·219	343·119	376·55	326·57

J. Davy(4) has determined the spec. grav. of sea-water, taken in June, 1847, at various distances from the coast of Guiana; the first line gives the distances from George-Town (at the mouth of the Demerara) expressed in English miles; the second, the correlative specific gravity:

0	¼	11	19	27	35	43	51	80
1·0036	1·0991	1·0210	1·026	1·0249	1·0236	1·0249	1·0258	1·0266

Jackson(5) has analysed sea-water, collected at various depths by Wilkes. A. is sea-water, collected March 4, 1839, at a depth of 100 fathoms, at 63° 18′ south latitude, and 55° west longitude;

(1) From the Gazzetta Toscana delle Scienze Medico-Fisiche, 1847, 113 in J. Pr. Chem. XLV, 235.

(2) Compt. Rend. XXVII, 429; J. Pr. Chem. XLVI, 106.

(3) J. Pharm. [3] XIII, 406.

(4) Edinb. New Phil. Journ. XLIV, 43.

(5) From the Proceedings of the 9th Annual Meeting of the Americ. Assoc. of Geol. and Nat. at Boston, 1847, in Sill. Am. J. [2] V, 41; J. Pr. Chem. XLVI, 110.

temperature in this depth = — 1°·1, at the level of the sea — 0°·6; spec. grav. 1·026. B. was collected July 29, 1839, at a depth of 450 fathoms, at 17° 54′ south latitude, and 112° 53′ west longitude; temperature at this depth + 6°·9, at the level of the sea 23°·3; spec. grav. 1·0275.—The quantities are represented in grains contained in a volume of sea-water, equal to that of 1000 grains of distilled water. Sea-water.

	Cl	SO_3	CO_2	PO_5	NaO & Na	MgO	CaO	Fe_2O_3	Sum total.
A.	20·73	1·29	1·29	0·06	10·12	1·64	0·83	trace	36·00
B.	20·40	2·43	0·68	0·09	10·76	2·48	1·06	trace	37·90

Respecting Müller's analysis of the North Sea water, see II. p. 251.

Brines and Mineral Waters. In Germany and Switzerland.—Fehling(1) has examined the brines of the salt-works in Würtemberg: A of *Friedrichshall*, B of *Clemenshall*, C of *Hall*, D of *Sulz*, E of *Wilhelmshall* near *Rottenmünster*, F and G (from two boreholes) of *Wilhelmshall* near *Schwenningen*; Deneke(2) has analysed the brine of *Werl* in Westphalia H; this brine contains in addition to the constituents enumerated below traces of iodide and bromide of magnesium, and alumina; C. Bromeis(3) has made an analysis of the water of the great brine-fountain, at *Nauheim* I; it contains traces of organic matter.

The table gives the composition in 100 parts of water.

	A	B	C	D	E
Spec. grav.	1·2028	1·2051	1·1990	1·1845	1·2026
Chloride of sodium	25·5625	25·9021	25·7180	23·4733	25·6251
„ „ magnesium	0·0059	trace	—	—	trace
Sulphate of lime	0·4374	0·4445	0·1705	0·5080	0·4613
„ „ magnesia	0·0221	—	—	—	—
„ „ soda	—	0·0197	0·0289	—	0·0051
Carbonate of lime	0·0100	0·0195	0·0037	0·0162	0·0294
Total amount of fixed constituents	26·0379	26·3859	25·9211	23·9975	26·1212

(1) Chemische Untersuchung der Soolen, des Stein- und Kochsalzes sowie der Mutterlaugen der Würtembergischen Salinen, Stuttgart 1847; Würtemberg. naturwissenschaftl. Jahreshefte IV, 36; J. Pr. Chem. XLV, 276 (in abstr.). For the numerous analyses of the various kinds of salts, boiler-deposits, &c., we refer to the pamphlet.—The mother-liquors of Kreuznach, Friedrichshall, Offenau, Hall, Ludwigshall, and Rappenau have been examined by Rieckher (Chemische Unters. einiger Soolmutterlaugen, Marbach 1846; Jahrb. Pr. Pharm. XV, 217, 289, 361.—The brine of the salt-work at Pyrmont has been analysed by Hugi (Arch. Pharm. [2] L, 143; J. Pr. Chem. XLII, 464); that of Sassendorf, near Socst, by Müller (Arch. Pharm. [2] L, 148; J. Pr. Chem. XLII, 464); who has likewise examined that of Salzkotten, and of Westernkotten in Westphalia (Arch. Pharm. [2] LI, 40). Deneke has examined the brine of Werl, in Westphalia (Ann. Ch. Pharm. LXV, 100.)

(2) Ann. Ch. Pharm. LXV, 100.

(3) Jahresbericht der Wetterauischen Gesellschaft für 1846—7, 47.

Brines and mineral waters. In Germany and Switzerland.

	F.	G.	H.	I.
Spec. grav.	1·1987	1·2004	1·0567	1·0213
Chloride of sodium	25·1570	25·2794	6·5183	2·3600
,, ,, magnesium	—	—	0·1345	0·0339
,, ,, calcium	0·0134	0·0276	0·2527	0·1935
,, ,, potassium	—	—	0·0022	0·0524
Sulphate of lime	0·4652	0·4553	0·2030	0·0052
Bromide of magnesium	—	—	—	0·0010
Bicarbonate of lime	—	—	—	0·2133
,, ,, protoxide of iron	—	—	—	0·0066
,, ,, protox. of manganese	—	—	—	0 0020
Carbonate of lime	0·0290	0·0278	0·1010	—
,, ,, magnesia	—	—	0·0155	—
,, ,, protoxide of iron	—	—	0·0186	—
Silicic acid	—	—	0·0355	0·0021
Sum of the fixed constituents	25·6646	25·7901	7·2813	2·8700
Free carbonic acid	—	—	0·0672	0·0928

Will(1) has analysed the water of the *Joseph's-well* (A.), of the *Wenzel's-well* (B.), and of the *Leopold's-well* (C.), at *Rippoldsau*; Liebig(2) examined the bitter water of *Friedrichshall*, near Hildburghausen (D.), which, in addition to the constituents enumerated, contains traces of sesquioxide of iron, alumina, silicic acid, and ammoniacal salts, not estimable; and(3) the mineral water of *Liebenstein*, in *Saxe-Meiningen* (E.), containing also traces of phosphate of alumina, arsenite of sesquioxide of iron, crenic acid, apocrenic acid, and organic matter which could not be estimated. Graeger(4) has published an analysis of the mineral water of *Popperode*, near *Mühlhausen* (F.), which contains traces of chloride of potassium; Van Kerckhoff(5), of the mineral water of *Mondorff*, near Luxemburg (G), containing traces of manganese, copper, tin, and organic matter, 0·000027 per cent of arsenious, and 0·000013 of antimonious acid. Hruschauer(6), of the water of *Kostreiniz*, in *Styria* (H.); and Fellenberg(7), of that of *Weissenburg*, in the Canton of Bern (I), which contains traces of lithia and iodine.

(1) Ann. Ch. Pharm. LXI, 181.

(2) Ann. Ch. Pharm. LXIII, 127; J. Pr. Chem. XLII, 463; J. Pharm. [3] XIII, 65.

(3) Ann. Ch. Pharm. LXIII, 221; J. Pr. Chem. XLII, 462; J. Pharm. [3] XIII, 49.

(4) Arch. Pharm. [2] XLIX, 1; J. Pr. Chem. XLII, 466.

(5) J. Pr. Chem. XLIII, 350.

(6) Ann. Ch. Pharm. LXIII, 229; J. Pr. Chem. XLII, 466; J. Pharm. [3] XIII, 49.

(7) J. Pharm. [3] XI, 259; J. Pr. Chem. XLII, 467.

Brines and mineral waters. In Germany and Switzerland.

The following table gives the quantities contained in 1000 parts by weight of water.

	A.	B.	C.	D.	E.
Spec. grav.	1·00385	1·00359	1·00371	1·0223	1·0025
Sulphate of soda	12·4776	9·8039	5·9411	60·560	2·2056
,, ,, potassa	0·5114	0·2265	0·2440	1·982	0 2757
,, ,, magnesia	2·3801	1·8273	3·6423	51·502	—
,, ,, lime	0·8463	0·8335	0·2203	13·465	0·2650
Chloride of magnesium	0·7957	0·7498	0·4421	39·390	1·2814
,, ,, sodium	—	—	—	79·560	2·7680
Carbonate of lime	11·1835	0·5400	13·3300	0·147	5·5196
,, ,, magnesia	0·2416	0·2500	1·4312	5·198	1·4161
,, ,, protoxide of iron	0·4037	0·2650	0·6250		0·7761
Bromide of magnesium	—	—	—	1·140	—
Alumina	0·0953	0·0840	0·0822	trace	—
Silicic acid	0·5180	0·4340	0·6790	trace	0·0909
Total amount of fixed constituents	29·4532	24·0140	26·6372	252·944	14·5984
Free carbonic acid	28·8095	25·6037	29·8420	4·020	23·4292

	F.	G.	H.	I.
Spec. grav.	1·00307	1·01131	1·00858	—
Sulphate of soda	—	—	0·075	0·375
,, ,, potassa	—	—	0·234	0·179
,, ,, magnesia	—	—	—	3·463
,, ,, lime	8·466	16·415	—	10·488
,, ,, strontia	—	—	—	0·142
Chloride of calcium	—	31·660	—	—
,, ,, magnesium	—	4·240	—	—
,, ,, sodium	15·900	87·212	3·126	0·069
,, ,, potassium	—	2·059	—	—
Carbonate of lime	0·811	0·855	1·369	0·524
,, ,, magnesia	1·950	0·064	3·092	0·398
,, ,, protoxide of iron	—	0·225	0·225	—
,, ,, soda	—	—	61·013	—
Bromide of magnesium	—	0·989	—	—
Iodide of magnesium	—	0·001	—	—
Phosphate of lime	—	—	—	0·092
Basic phosphate of alumina	—	—	0·163	—
Silicate of soda	—	—	—	0·140
Silicic acid	trace	0·072	0·335	0·209
Sesquioxide of iron	—	—	—	0·018
Total amount of fixed constituents	27·127	143·796	69 632	16·097
Free carbonic acid	—	0·806	35·801	—
Nitrogen	—	9·228	—	—

In the following table we unite the analyses by Witting(1) of the

(1) Arch. Pharm. [2] L, 31.

Brines and mineral waters. In Germany and Switzerland.

waters of the *Friedrich-Wilhelms-*, the *Seraphinen-*, (A.), and the *Anna-well* (B.) at *Levern*, in the Prussian Regierungsbezirk Minden, in each of which the presence of traces of iodine and bromine was proved; the analysis of the sulphur-water at *Lippspringe* (C.), by the same author(1); this water contains, moreover, traces of iodine, potassa, and alumina; the analysis of the mineral water of *Kochel* in the Bavarian Highland (D.), by Pettenkofer(2); and the analysis by Lade(3) of the *Kochbrunnen*, at *Wiesbaden* (E.), in which traces of ammonia, of lithia, of manganese, of alumina, of phosphoric acid, and of organic matter were found.

In these various analyses it is stated how many grains of fixed constituents, and how many cubic inches of carbonic acid, &c., are contained in 16 ounces = 7680 grains of mineral water.

	A.	B.	C.	D.	E.
Spec. grav.	—	—	—	1·001	1·0062
Sulphate of lime	4·41	3·25	13·28	—	0·7219
„ „ soda	2·19	2·25	—	2·688	—
„ „ magnesia	0 53	1·25	1·30	—	—
Bicarbonate of soda	—	—	—	8·456	—
Carbonate of soda	—	—	0·44	—	—
„ „ lime	4·41	5·25	1·43	0·168	3·2141
„ „ magnesia	—	—	0·36	trace	0·0507
„ „ protoxide of iron	1·10	0·28	—	—	0·0668
Chloride of potassium	—	—	—	trace	1·3816
„ „ sodium	—	—	0·06	0·050	53·2209
„ „ calcium	0·66	0·75	0·46	—	3·6088
„ „ magnesium	0·26	0·50	0·14	—	1·2096
Bromide of magnesium	—	—	—	—	0·1290
Phosph. of protoxide of iron	—	—	—	0·560	—
„ „ „ „ manganese	—	—	—		—
Silicic acid	trace	trace	trace	trace	0·4785
Organic matter	—	—	trace	0·853	—
Total amount of fixed constituents	13·56	13·53	17·47	12·775	64·0819
Free carbonic acid	5·25	7·50	1·120	5·183	10·00
Atmospheric air	0·25	1·00	1·060	—	—
Nitrogen		0·50	—	—	—
Hydrosulphuric acid	0·12	trace	2·015	trace	—

The water of the *Kochbrunnen*, at *Wiesbaden* (A.), has been examined also by Figuier and Mialhe(4), who have analysed, moreover, the water of the wells in the *Kölnischer Hof* (B.) and in

(1) Arch. Pharm. [2] LI, 280.
(2) Repert. Pharm. [2] XLVII, 375; Arch. Pharm. [2] LV, 180.
(3) Ann. Ch. Pharm. LXVI, 170.
(4) J. Pharm. [3] XIII, 401; J. Chim. Méd. [3] IV, 635.

Brines and mineral waters.

In Germany and Switzerland.

the *Adler* (C.) in the same town, that of the wells No. 2 (D.) and No. 5 (E.) at *Nauheim;* that of the Elizabeth-well (F.), and of the Imperial-well (G.) at *Homburg,* that of the well No. 6 a (H.) and No. 6 b (I.) at *Soden;* both the latter contain, moreover, traces of alumina. The following table gives the quantities of fixed constituents expressed in grammes contained in 1 litre of water.

	A.	B.	C.	D.	E.
Chloride of sodium . . .	7·332	6 791	7·316	23·046	27·333
„ „ magnesium . . .	0·246	0·280	0·254	3·760	2·653
„ „ potassium . . .	0·038	0·101	0·043	1·005	—
Sulphate of lime	0·085	0·136	0·098	0·627	0·047
Carbonate of lime . . .	0·180	0·150	0·450	1·095	1·280
„ „ magnesia . . .	0·008	trace	trace	—	—
„ „ protoxide of iron .	0·009	0·010	0·015	0·121	0·016
Bromide of magnesium . .	0·019	0·016	0·008	0·090	0·100
Silicate of soda	0·183	trace	0·041	0·039	0·005
Total amount of fixed constituents .	8·100	7·487	8·225	29·783	31·434

	F.	G.	H.	I.	
Chloride of sodium . . .	10·649	16·021	14·327	10·898	
„ „ magnesium . . .	1·187	1·302	0·311	0·284	
„ „ potassium . . .	0·030	0·027	0·207	0·229	
Sulphate of lime	0·027	0·018	0·094	0·082	
Carbonate of lime . . .	0·940	1·027	0·540	0·979	
„ „ magnesia . . .	0·360	trace	0·108	0·098	
„ „ protoxide of iron .	0·043	0·097	0·045	0 037	
Silicate of soda	0·064	0·031	0·061	0·064	
Total amount of fixed constituents .	13·300	18·523	15·691	12·671	

In France.—Figuier and Mialhe compare the above German with French mineral waters, of which they have examined that of *Niederbronn* in *Alsace* (A., which contains also traces of manganese), that of the *Source de la Place* (B.) and of the *Source de l'Intérieur de l'établissement* (C.) of *Bourbonne,* and that of *Balaruc* (D.). They point out that the German mineral waters may be imitated by appropriately mixing sea-water and ordinary water with the French waters, first enumerated. The same chemists have examined(1), moreover, the mineral water of *Rieumajou,* near *Salvétat,* in the Dep. *de l'Hérault* (E.); Legrip(2) has analysed the water of *Doulaux* in the Dep. of the *Creuse* (F.); Girardin(3) the water of the well of St. Paul(G.), and of la Maréquerie (H.) at *Rouen;* E. Marchand(4) has investigated

(1) J. Pharm. [3] XI, 338; J. Pr. Chem. XLII, 465.
(2) J. Chim. Méd. [3] IV, 83.
(3) J. Chim. Méd. [3] IV, 643; J. Pharm. [3] XV, 113.
(4) J. Chim. Méd. [3] IV, 693.

Mineral waters. In France.

the water of *Valmont* (I.), which contains, in addition to the ingredients enumerated, 0·00087 of a green resin, insoluble in water, difficultly soluble in ether and more soluble in alcohol, and very minute traces of copper. The following table gives the quantities of the solid constituents expressed in grammes, and of the gases expressed in cubic centimetres, contained in 1 litre of water.

	A.	B.	C.	D.	E.
Chloride of sodium	3·070	5·783	5·771	6·802	0·007
,, ,, magnesium	0·288	0·392	0·381	1·074	—
,, ,, potassium	0·260	—	—	—	—
,, ,, calcium	0 825	—	—	—	—
Bromide of sodium	0·040	0·065	0·064	0·003	—
,, ,, magnesium	—	—	—	0·032	—
Sulphate of lime	0·090	0·899	0·879	0·803	—
,, ,, potassa	—	0·149	0·129	0·053	—
,, ,, soda	—	—	—	—	0·029
Carbonate of soda	—	—	—	—	0·214
,, ,, lime	0·120	0·108	0·098	0·270	0·770
,, ,, magnesia	—	—	—	0·030	0·060
,, ,, protoxide of iron	0·091	—	—	—	—
Silicic acid	—	—	—	—	0·071
Sesquioxide of iron	—	—	—	trace	0·031
Alumina	trace	0·030	0·029	—	trace
Silicate of soda	trace	0·120	0·120	0·013	—
Organic matter and loss	—	—	—	—	0·048
Total amount of fixed constituents	4·784	7·546	7·471	9·080	1·230
Free carbonic acid	—	—	—	—	739

	F.	G.	H.	I.
Chloride of sodium	0·0350	—	—	0·07297
,, ,, magnesium	—	0·028	0·041	trace
,, ,, potassium	—	—	—	0·00949
,, ,, calcium	—	0·046	0·087	0·00454
Nitrate of lime	—	—	—	0·00382
Sulphate of lime	—	0·008	0·012	0·01075
,, ,, potassa	—	—	—	0·00465
,, ,, magnesia	—	0·006	0·008	—
,, ,, protoxide of iron	—	trace	0·001	—
,, ,, alumina	—	trace	—	—
Carbonate of ammonia	—	—	—	0·00227
,, ,, lime	0·0100	0·068	0·079	0·28865
,, ,, magnesia	—	—	0·011	0·04514
,, ,, protoxide of iron	0·0750	0·069	0·094	0·00558
Crenate of protoxide of iron	—			—
Silicic acid	0·0210	0·002	0·003	0·01260
Alumina	0·0074	—	—	—
Organic matter and loss	0·0040	0·005	0·007	—
Total amount of fixed constituents	0·1524	0·232	0·343	0.46133
Free carbonic acid	340	—	—	766

Mineral waters. In France.

Henry(1) has examined the mineral water of *Cassèjouls* in the Dep. des Aveyron (A,) containing traces of potassa and manganese, and, in the deposit, of arsenic; the water(2) of the Source Grande Grille (B.), of the Source nouvelle (C.), of the Source Prè-Salé (D), and of the Nouvelle-Source Célestins (E.), at *Vichy*, of the Source du Puit (F.), of the Source de l'Hôpital (G.), of the Source des Dames (H.), of the Source de l'Abbatoir (I.) at *Cusset*, of the first (K.) and of the second (L.) well at *Hauterive*. All these waters contain traces of strontia, of lithia, of iodine, of bromine, of organic matter, and perhaps of phosphates and nitrates. The table gives the amount of fixed constituents, expressed in grammes, and of gases expressed in litres, contained in 1 litre of water.

	A.	B.	C.	D.	E.	F.
Bicarbonate of soda	—	4·900	4·840	4·700	4·137	4·620
„ „ lime	0·030	0·107	0·094	0·445	0·277	0·380
„ „ magnesia		0·065	0·057	0·408	0·210	0·220
„ „ protoxide of iron	0·086	—	—	—	—	—
Crenate of protoxide of iron		—	—	—	—	—
Sulphate of soda	—	0·469	0·410	0·241	0·170	0·400
„ „ potassa	—	0·020	0·004	0·020	0·020	0·020
„ „ lime	0·074	—	—	—	—	—
Silicate of alumina		0·230	0·233	0·070	undeter.	0·080
Iron and manganese	—	0·001	0·001	0·001	0·001	0·001
Silicate of soda	—	0·400	0·340	0·276	0·120	0·030
Chloride of sodium	0·060	0·538	0·500	0·295	0·358	0·380
Chloride of potassium	—	0·004	0·003	0·004	0·022	0·020
Total amount of fixed constituents	0·250	6·734	6·482	6·860	5·315	6·151
Free carbonic acid	0·67	0·231	0·272	0·310	0·501	1·040

	G.	H.	I.	K.	L.
Bicarbonate of soda	5·150	4·100	2·353	5·240	5·203
„ „ lime	0·661	0·200	0·158	0·140	0·120
„ „ magnesia	0·330	0 039	0·405		
Sulphate of soda	0·502	0·440	1·034	0·320	0·275
„ „ potassa	0·010	0·005	0·020	trace	trace
Silicate of alumina	0·120	—	0·060	0·050	0·060
Iron and manganese	0·120	0·001			
Silicate of soda	0·120	0·030	0·130	0·050	0·060
Chloride of sodium	0·460	0·400	0·354	0·410	0·482
„ „ potassium	0·020	0·015	0·011	0·001	0·010
Total amount of fixed constituents	7·253	5·230	4·165	6·170	6·150
Free carbonic acid	0·280	0·480	0·640	0·511	0·502

(1) J. Pharm. [3] XII, 241; J. Pr. Chem. XLII, 462.
(2) J. Pharm. [3] XIII, 5.

Mineral waters. In France.

Boullay and Henry(1) have discussed the question, in what state the sulphur is present in the sulphur-waters of *Barzun* and *Barège*, in the Pyrenees; they arrive at the conclusion, that the water originally contains a monosulphide (sulphide of sodium); that the waters, when coming forth, contain sulphide of sodium and variable quantities of hydrosulphuric acid, they consider to be caused by air-currents prevailing in the interior of the earth; but they deny positively that hydrosulphate of sulphide of potassium is present as a definite chemical compound.

In Italy and Belgium.—The water of the *Mofetta di S. Quirico* (A.), in Tuscany, has been examined by Orosi(2); that of *Prè-Saint-Didier*, near *Courmayeur*, in Piedmont, has been investigated by Abbéne(3), who examined that of the upper (B.) and that of the lower (C.) well; both contain traces of bromine and iodine. Laminne(4) has examined the water of *Tongern* (D.) in Belgium. The table gives the quantities contained in 1000 parts of water.

	A.	B.	C.	D.
Spec. grav.	—	1.00072	1·00123	—
Chloride of potassium	0·0320	—	—	—
„ „ sodium	0·0188	0·036	0·050	0·0090
„ „ magnesium	0·0377	0·046	0·060	—
„ „ calcium	—			—
Carbonate of soda	—	—	—	0·0194
„ „ lime	1·1367	0·197	0·310	0·1080
„ „ magnesia	0·2428	0·049	0·077	0·0274
„ „ protoxide of iron	0·0741	—	—	—
„ „ protox. of manganese	0·0447	—	—	—
Sulphate of potassa	0·0150	trace	trace	0·0192
„ „ soda	0·2100	0·134	0·270	—
„ „ lime	—	0·040	0·060	—
Phosphate of soda	—	—	—	0·0010
Alumina	0·0049	trace	trace	0·0020
Sesquioxide of iron	—	0·006	0·010	0·0060
Sesquioxide of manganese	—	0·002	0·003	—
Silicic acid	0·0697	0·016	0·020	—
Crenic acid	—	—	—	0·0040
Organic substances	0·0501	0·034	0·040	0·0140
Total amount of fixed constituents	1·9365	0·560	0·900	0·2100
Free carbonic acid	3·2940	—	—	—

(1) J. Pharm. [3] XI, 177.

(2) From the Gaz. Toscana, 1847, 99 in Pharm. Centr. 1847, 413; J. Pr. Chem. XLII, 468.

(3) J. Pharm. [3] XII. 412.

(4) J. Pharm. [3] XIII, 354; J. Chim. Méd. [3] IV, 461.

Mineral waters. In Great Britain.

In Great Britain.—Merck and Galloway(1) have analysed the mineral water of *Bath* (King's-bath) (H.); Th. J. Herapath(2) that of *Beacon-Hill*, near *Bath* (B.); Abel and Rowney(3) several mineral waters of *Cheltenham;* namely, the *Cambray-water* (C.), the saline *Pittville-water* (D.), the sulphur-water No. 1. Royal Old Wells (E.), and the saline-water No. 4. Royal Old Wells (F.). The various Cheltenham-waters contained traces of hydrosulphuric acid. Ure(4) has examined the mineral water of *Tenbury*, in Worcestershire (G.). The table gives the quantity of fixed constituents, expressed in grains, and of gases, expressed in English cubic inches, contained in an imperial gallon (the volume of 70,000 grains of water):

	A.	B.	C.	D.	E.	F.	G.
Spec. grav.	—	—	1·0010	1·0076	1·0064	1·0079	1·0208
Chloride of potassium	—	—	5·0491	—	—	—	—
„ „ calcium	—	1·120	—	—	9·2575	—	425·6
„ „ magnesium	14·581		—	—	52·6197	8·0003	51·3
„ „ sodium	12·642	4·000	1·2138	481·1933	229·7876	590·3310	1301·4
Bromide of calcium	—	—	—	—	2·0272	—	—
„ „ sodium	—	—	—	3·2928	—	—	16·2
Iodide of sodium	—	—	—	trace	—	—	—
Bromide of magnesium	—	—	—	—	—	3·0632	—
Iodide of magnesium	—	—	—	—	—	0·4361	—
Sulphate of soda	19·229	0·320	—	112·8666	234·0562	94·9410	—
„ „ magnesia	—		—	—	—	—	—
„ „ lime	80·052	4·480	—	—	—	—	6·0
„ „ potassa	4·641	—	0·4781	2·9512	trace	trace	—
Phosphate of lime	—	—	0·5579	trace	trace	trace	—
Ph. of sesquiox. of iron	—	—	—	—	0·1834	—	—
Carb. of lime	8·820	11·200	25·1209	7·7021	22·0808	17·0611	—
„ „ magnesia	0·329	trace	4·3624	11·3897	1·9719	6·8026	—
„ „ protox. of iron	1·071	0·012	2·8938	—	0·5999	trace	1·5
„ „ potassa	—	0·010	—	—	—	—	—
„ „ soda	—	—	4·1867	20·1481	—	—	—
Org. extractive matter	—	—	0·0098	3·4993	0·0231	18·0530	—
Crenate of magnesia	—	0·080	—	—	—	—	—
Apocrenate of magnesia	—	0·040	—	—	—	—	—
Crenic acid	—	—	0·2429	0·3591	16·8245	0·3332	—
Apocrenic acid	—	—	0·1470	—	—	—	—
Silicic acid	2·982	trace	0·6678	2·7755	1·0129	2·7468	—
Nitrates	—	trace	—	—	—	—	—
Loss	—	—	0·3598	—0·5719	1·8004	0·0091	—
Total amount of fixed constituents	144·098	21·262	45·2900	645·6058	572·2451	741·7774	1802·0
Free carbonic acid	—	—	19·919	16·254	32·705	25·294	

(1) Phil. Mag. [3] XXXI, 56; Chem. Soc. Mem. III, 262; Ann. Ch. Pharm. LXIII, 318; J. Pr. Chem. XLII, 467.

(2) Chem. Gaz. 1848, 430.

(3) Chem. Soc. Qu. J. I, 193; Ann. Ch. Pharm. LXIX, 246.

(4) Pharm. J. Trans. VIII, 128.

Mineral waters. In Iceland.

In Iceland.—Damour(1) has examined various siliceous spring-waters of Iceland, namely that of the great *Geysir* (A.) (spec. grav. 1·001, odour of hydrosulphuric acid), that of the spring *Badstofa* (Reykir) (B.), that of the spring south of the *Hvergarden* (Reykir) (C.), that of the spring *Store-Hver*, in the middle of the *Hvergarden* (D.), and of the spring of *Laugarnes*, near *Reykjavik* (E.). 1000 parts of water contain:

	A.	B.	C.	D.	E.
Sulphate of potassa	0·0180	0·0229	—	—	—
„ „ soda	0·1343	0·0103	—	—	0·0221
„ „ magnesia	0·0091	—	—	—	—
„ „ lime	—	0·0400	—	—	—
Chloride of sodium	0·2638	0·2873	—	—	0·0547
Chlorine	—	—	0·1732	undeter.	—
Soda	0·1227	0·0711	0·3188	0·3072	0·0508
Potassa	—	—	—	0·0150	—
Silicic acid	0·5190	0·2630	0·3240	0·3160	0·1350
Sulphur	0·0036	0·0061	0·0091	0·0030	0·0019
Sulphuric acid	—	—	undeter.	undeter.	—
Carbonic acid	0·1520	undeter.	undeter.	undeter.	undeter.

In the East Indies and South America.—Mulder(2) has examined the mineral water (A.) of *Assinan*, in the Dutch possessions in the East Indies; Lewy(3) the water (B.) of a thermal spring (temperature 69°·4) in the *Paramo de Ruiz*, in New Granada (South America) which contains free sulphuric and hydrochloric acids (spec. grav. 1·0073). 1000 parts of the water contain:

	A.	B.
Chloride of calcium	1·0129	—
„ „ magnesium	0·5713	—
„ „ sodium	16·3340	0·91
Iodide of magnesium	0·0775	—
Sulphate of magnesia	—	0·94
„ „ lime	—	0·34
„ „ alumina	—	1·66
„ „ sesquioxide of iron	—	1·02
Silicic acid	0·0267	0·18
Sulphuric acid	—	2·55
Hydrochloric acid	—	0·33

(1) Ann. Ch. Phys. [3] XIX, 470.

(2) Scheik. Onderz. IV, 524.

(3) Compt. Rend. XXIV, 449. Additional remarks of Boussingault on volcanic waters, containing free sulphuric acid, Compt. Rend. XXIV, 397; Ann. Ch. Phys. [3] XX, 109; J. Pharm. [3] XI, 487 (in abstr.); J. Pr. Chem. XL, 438; Ann. Ch. Pharm. LXIV, 292; Pogg. Ann. LXXI, 444.

Deposits of Springs. Ochres.—The following investigations of deposits of springs (ochres) have been made during 1847 and 1848; of the deposit of the well at *Driburg* (A.) by Ludwig(1); of the deposits of the bath (B.) and of the well (C.) at *Alexisbad*, in the Hartz, by Rammelsberg(2); of the deposit of the large brine-fountain at *Nauheim* (D.) by Ewald(3); of the deposit of the well of M. Ruéffi, near *Foix* (E.), of the well of the *Madelaine de Flourens* (F.), and of another well (G.) near *Toulouse*, by Filhol(4). The deposits analysed by Filhol had been dried at 100°.

	A.	B.	C.	D.	E.	F.	G.
Sesquioxide of iron	57·303	65·30	53·88	49·86	40·570	50·421	53·100
Sesquiox. of manganese	—	0·76	6·95	0·40	trace	—	—
Lime	6 683	0·15	0·40	—	—	—	—
Magnesia	—	0·04	0·12	—	—	—	—
Protoxide of iron	—	—	1·68	—	—	—	—
Carbonate of lime	—	—	—	20·81	2·108	2·359	4·503
„ „ magnesia	—	—	—	—	1·060	0·825	0·675
Chloride of sodium and other soluble salts	—	—	—	2·59	—	—	—
Alumina	—	—	—	—	—	3·970	2·910
Sulphuric acid	0·543	—	—	—	—	—	—
Soluble silicic acid	—	0·43	6·91	2·81	5·000	2·000	4·200
Arsenic	—	0·958	0·025	—	0·050	0·032	0·058
Arsenious acid	0·063	—	—	—	—	—	—
Copper	—	0·017	0·001	—	trace	—	—
Tin	—	0·003		—	—	—	—
Water	23·333	26·33	23·93	23·53	18·000	20·027	19·508
Organic substances	0·542			—	16·800	15·189	12·327
Sand	5·388	6·02	6·71	—	16·412	3·970	2·719
Carbonic acid	6·145	—	1·36	—	—	—	—
Loss		—	—	—	—	—	—
	100·000	100·008	101·966	100·00	100·000	100·100	100·000

The deposit which is formed in the tubes through which the water is conducted from *Arcueil* to Paris contains, according to Boutron-Charlard and Henry(5), 90·0 per cent of carbonate of lime, 6·0 of carbonate of magnesia, 2·2 of sulphate of lime, and 1·8 of silicic acid, sesquioxide of iron and organic matter.

(1) Arch. Pharm. [2] LI, 145.
(2) Pogg. Ann. LXXII, 571.
(3) Jahresbericht der Wetterauischen Gesellschaft für 1846—7. 77.
(4) J. Pharm. [3] XIII, 13.
(5) J. Pharm. [3] XIV, 173.

Arsenic, copper &c. in mineral waters.

Arsenic, Copper, &c. in Mineral Waters.—In 1847 and 1848, numerous statements have been made respecting the presence of many oxides of the heavy metals in various mineral waters, which previously had been overlooked. The insignificant remarks of Paracelsus', of Thurneysser's and several other alchemists of the 16th century, regarding the presence of arsenic, antimony, vitriol, &c., in mineral waters, being left out of consideration, until of late, very few definite facts had been established in this respect. In 1823, Ficinus(1) asserted that he had found protoxide of copper in all the wells of *Teplitz*, and in the same year Schweigger(2) conjectured that the *Karlsbad* water might contain nickel. Bley(3) determined, in 1828, the quantity of copper contained in the water of the *Erna-well*, in the Selke-valley, near the Hartz; he found in 16 oz. 0·0496 grains. Berzelius(4) found 0·0133 of sulphate of protoxide of zinc in 1000 parts of the mineral water of *Ronneby*, which he examined jointly with Trolle-Wachtmeister, in 1827; and in 1839(5) traces of binoxide of tin and protoxide of copper in the *Saidschütz* water. In 1840, Schafhäutl(6) pointed out the presence of arsenic in iron-ores, which had been deposited from water, and the frequent occurrence of this metal and of antimony and tin in iron. Tripier(7) stated, in 1840, that 1 litre of the mineral water of *Hammam Mes Kutin*, near Constantine, contains 0·0005 grm. of arsenic, an assertion which was doubted at that time, inasmuch as the presence of arsenic had not been mentioned in the former analysis of this water by Henry and Chevallier; these two chemists, however, confirmed, in 1843, the statement of Tripier respecting the presence of arsenic in that water(8). In 1845, Bauer(9) found teroxide of antimony in a mineral water, from the neighbourhood of *Schüpfheim*, in the canton of Lucerne; according to his experiments, 349 ounces of water contained 1·507 grains.

(1) From Froriep's Notizen VI, 194 in Berzelius' Jahresber. IV, 132.

(2) From Schweigger's Neues Journal für Ch. u. Ph. N. R. IX, 388 in Berzelius' Jahresber. IV. 133.

(3) Trommsdorff's Neues Journal der Pharm. XVIII, 2.

(4) From Abhandl. der Schwed. Akad. für 1827, in Berzelius' Jahresber. VIII, 237.

(5) Compt. Rend. IX, 164; Ann. Ch. Pharm. XXXI, 240.

(6) Phil. Mag [3] XVII, 570; J. Pr. Chem. XXI, 129.

(7) J. Chim. Méd. [2] VI, 278; Arch. Pharm. [2] XXVI, 327.

(8) J. Chim. Méd. [3] I, 413.

(9) Jahrb. Pr. Pharm. X, 3.

Arsenic, copper &c. in mineral waters.

As far back as 1844, Walchner(1) showed that small quantities of copper and arsenic are contained in every iron-ore, and that these metals occur together with iron in arable soil, in clay, and in marl. He found copper and arsenic in the meteoric iron of Pallas(2), in the Mexican meteoric iron of *Yuanhuitlan*, near *Oaxaga*, in specimens from Tenessee, and from North America. The same metals were found in the deposits (ochres) of the chalybeate wells of *Griesbach*, *Rippoldsau*, *Rothenfels*, and *Steinach* in the *Schwarzwald*, of *Lamscheid* near the *Hunsrücken*, of the *Brohl-valley*, of *Cannstadt*, of *Ems*, of *Schwalbach*, of *Wiesbaden*, and of *Pyrmont;* in the deposit of the Wiesbaden-water, moreover, antimony was detected.

With reference to German mineral waters, the presence of arsenic in the water at *Wiesbaden* was first pointed out by Figuier(3); he determined the quantity of arsenic present in 200 grms. of ochre (the residue, insoluble in boiling water, obtained on evaporation of 359 litres of mineral water), which was found to be 0·124 grm.; he is of opinion that it is present in the water, in the form of arsenite of soda.—Will(4) found arsenic, copper, lead, tin and antimony both in the ochre spontaneously deposited and in the residue obtained on evaporation, from the wells of *Rippoldsau;* provided the ratio of protoxide of iron and the oxides of the metals just enumerated be the same in the water as in the sediment, 10,000 parts of water contain :

	Joseph's-well.	Wenzel's-well..	Leopold's-well.
Sesquioxide of iron . . .	0·2784	0.1835	0·431
Arsenious acid	0·0060	0·0040	0·0090
Protoxide of tin	0·00025	0·00017	0·00038
Teroxide of antimony . . .	0·00016	0·00010	0·00024
Protoxide of lead . . .	0·00025	0·00016	0·00037
Protoxide of copper . . .	0·00104	0·00069	0·00156

In the deposits of various Wiesbaden-wells he found for 100 parts of sesquioxide of iron from 1·98 to 2·94 parts of another metal,

(1) Amtlicher Bericht über die 22. Versammlung deutscher Naturforscher u. Aerzte in Bremen, 58; Compt. Rend. XXIII, 612; Ann. Ch. Pharm. LXI, 109; J. Pr. Chem. XL, 109.

(2) Monheim found, in 1816, arsenic in the alleged meteoric iron of Aachen, and his statement was confirmed by Stromeyer; the latter chemist detected the same element in a mass of iron, which was found near Magdeburg, and believed to be meteoric; Rummler stated, in 1840, that the olivine, which occurs in Pallas' meteoric iron, and in that of Atacama, contains arsenious acid, a statement which is corroborated by Berzelius (Jahresber. 1840) with reference to the olivine of the former origin.

(3) Compt. Rend. XXIII, 634.

(4) Ann. Ch. Pharm. LXI, 192.

Arsenic, copper &c. in mineral waters.

which, when assumed to consist entirely of arsenic, corresponds to from 3·0 to 3·9 parts of arsenious acid; also in the ochres of the *Soden-* and *Homburg-wells* he found arsenic and tin.—Keller(1) examined several deposits, under Buchner's jun. direction; in the ochre of the *Ragoczy-* and *Pandur-wells* of *Kissingen* he found only a doubtful trace of copper, but proved the presence of arsenic; the ochre of the chalybeate well of *Brückenau* contains only a trace of arsenic, but a considerable quantity of copper; the ochres of both places contain, moreover, tin. In the ochre deposited by the chalybeate water of *Kellberg*, near *Passau*, neither arsenic nor copper could be traced with certainty. At a later period, Keller(2) has communicated the following quantitative determinations:

	AsO_3	SbO_3	SnO	PbO	CuO
1 Krug (=18720 grains.) Pandur :	0·0216	0·0024	0·0025	0·0020	trace
„ „ „ „ Ragoczy :	0·0144	0·0028	0·0031	0·0025	trace
1 Bavarian Mass of Brückenau-water:	0·0001	0·0001	0·0001	—	0·0021 grain.

Liebig found arsenic in the mineral water of *Liebenstein*, in *Saxe-Meiningen* (comp. II. p. 258). Ludwig(3) determined the ratio of sesquioxide of iron and arsenious acid in the ochre deposited from the water of *Driburg*; he found it to be 57·30 of the former to 0·063 per cent of the latter; the ochre of the *Liebenstein-well* yielded 35·88 of sesquioxide of iron and 0·7612 of tersulphide of arsenic, in which a small amount of bisulphide of tin is included.—According to Rammelsberg(4), the ochre of the *Alexisbad* (bath-well), near the Hartz, contains 65·9 per cent of sesquioxide of iron, 0·958 of arsenic, 0·017 of copper, and 0·003 of tin; he believes that the arsenic is present in this ochre in the form of arsenic acid; the water of the *Alexisbrunnen* contains from 53·9 to 55·8 of sesquioxide of iron, 0·025 of arsenic, and 0·001 of copper and tin. The same ochres have been examined by Bley and Diesel(5), who found in the ochre deposited from the *Alexisbad* 0·92125 of arsenious acid and traces of antimony, in that from the *Alexisbrunnen* 0·1125 of arsenic and no antimony; they state that the latter ochre contains, moreover, zinc. Fischer(6) in Ovelgönne found arsenic and copper in the ochre of the *Sauerbrunnen*, in *Wildungen*. According to Van Kerckhoff, the mineral

(1) Anzeigen der Baierschen Akad. 1847, Nro. 75; J. Pr. Chem. XL, 442; Jahrb. Pr. Pharm. XV, 20.

(2) Repert. Pharm. [2] XLVIII, 289; Arch. Pharm. [2] LV, 181.

(3) Arch. Pharm. [2] LI, 145.

(4) Pogg. Ann. LXXII. 571. For the complete analysis we refer to II. p. 267.

(5) Arch. Pharm. [2] LII, 268.

(6) Ibid. 263.

Arsenic, copper &c. in mineral waters.

water of *Mondorff* (comp. II. p. 258), near *Luxemburg,* contains arsenic, antimony, manganesc, copper and tin.

With reference to French mineral waters, Flandin(1) found neither arsenic nor copper in the chalybeate water of *Passy,* near *Paris;* Chatin(2) arrived at the same result, but proved the prcsence of arsenic in the watcr of *Trianon;* 2500 litres of the latter water (to which corresponds about 1 kilogramme of ochre) contain from 28 to 30 milligrammes of arsenic. Chatin thinks it possible that the occurrence of arsenic may be limited to those chalybeate waters in which, as in that of *Trianon,* the metal is present in the state of carbonate of the protoxide, while it is wanting in such waters as contain, like the waters of *Passy,* the iron in the form of sulphate. Chevalier(3) found in the ochre of the wells of *Forges* undeterminable traces of copper, but no arsenic; Lemonnier(4) traces of arsenic in the ochre of the chalybeate springs of *Bagnères de Bigorre,* in the Pyrenees; O. Henry(5) in the ochre of the well of *Casséjouls* (Dep. des Aveyron), and Langlois(6) in the ochre, and in the residue obtained on evaporation, of the water of a chalybeate well in the neighbourhood of *Metz.* Chevallier and Schauefele(7) found 0·0015 grm. of arsenic acid in the residue of 2·5 litres of a water at *Bussang,* in the Vosges; its ochre likewise contained arscnic and very minute traces only of copper. The same chemists found traces of arsenic in the mineral waters of *Chatenois* and *Niederbronn* (Dep. Lower Rhine), of *Sulzbach, Sulzmatt* and *Watweiler* (Dep. Upper Rhine), and more appreciable quantities in the ochre-deposits of these waters; they give a synopsis of mineral waters, chiefly of the French, with reference to arsenic; the presence of this element is pointed out on the authority of Chevallier and Gobley, in a great number of cases. The latter chemists(8) found arsenic in the ochre, but not in the residue obtained on evaporation, of the water of *Cransac* (Dep. des Aveyron); traces of copper, but no arsenic, in the ochre of *Chateau-Thierry* (Aisne); arsenic in the ochre of *Royat* (Puy-de-Dome); traccs of arsenic and copper in the ochre of *Hermonville* (Marne), of copper in the ochre of *Pargny,* of arsenic

(1) Compt. Rend. XXIII, 635.

(2) Compt. Rend. XXIII, 931; J. Chim. Méd. [3] III, 3; Ann. Ch. Phys. [3] XXII, 327.

(3) J. Chim. Méd. [3] III, 3.

(4) Compt. Rend. XXIV, 629; J. Chim. Méd. [3] III, 381; J. Pr. Chem. XLI, 351.

(5) J. Pharm. [3] XII, 241.

(6) J. Chim. Méd. [3] IV, 405.

(7) J. Chim. Méd [3] IV, 401; Compt. Rend. XXV, 750 (partially).

(8) J. Pharm. [3] XIII, 324.

Arsenic, copper &c. in mineral waters.

in the water of *Hauterive* (Allier), in the ochre of *Martigné-Briant* (Maine-et-Loire), in the water (scarcely) and in the ochre (more perceptibly) of *Fenu* (Maine-et-Loire), and in the water and the ochre of *Provins* (Seine-et-Marne); neither arsenic nor copper in the ochre of *Amiens* (Somme); traces of copper in the ochre of *Candé* (Vienne); neither arsenic nor copper in the water of *St. Remy-l'Honoré* (Seine-et-Oise); arsenic in the water of *Vichy* (Allier), *Mont-Dore* and *Saint-Mart* (Puy-de-Dome); arsenic neither in the water nor in the ochre of *Saint-Allyre* (Puy-de-Dome), not in the water but in the ochre of *Jaude* (Puy-de-Dome); arsenic not in the water of *St. Amand* (Nord) but in that of *Plombières;* arsenic in the water and in the ochre (together with copper) of *Bourbonne-les-Bains* (Haute-Marne), and in the ochre of all the wells of *Spa.*—Girardin(1) found neither arsenic nor copper in the water and the ochre of the chalybeate wells of *St. Paul* and *la Maréquerie,* at *Rouen.* According to E. Marchand(2), the ochre of the well of *Valmont* is free from arsenic, but contains minute traces of copper.—For some collateral determinations of Filhol we refer to the synopsis of ochre-analyses, II. p. 267.

(1) J. Chim. Méd. [3] IV, 643. (2) J. Chim. Méd. [3] IV, 693.

TECHNICAL CHEMISTRY.

Metals and Alloys. Carbon in Iron.—Karsten(1) has examined the various carbides of iron, known technically as pig- or cast-iron, steel, and malleable or bar-iron, with a view of ascertaining the limit, in the amount of carbon, which gives to each group its peculiarity. He employed as the point of departure for the higher limit, some iron, (obtained from spathic iron-stone by wood-charcoal), which contained only chemically combined carbon. In order to eliminate the influence of the method over the results, he determined the carbon by various means; the methods and results are given in the following table:

By combustion with protoxide of copper . . .	= 4·2835	per cent.
„ „ chlorate of potassa and chrom. of lead	= 5·7046	„ „
„ „ „ „ „	= 5·6987	„ „
With chloride of copper	= 5·5523	„ „
„ „ „	= 5·6978	„ „
With sesquichloride of iron (sublimed) . . .	= 5·4232	„ „
„ „ „ (prepared in the moist way) .	= 5·2867	„ „
With chloride of silver	= 5·6056	„ „
„ „ „	= 5·7234	„ „
Mean of the analyses	= 5·4417	

or with omission of the first analysis = 5·5865 per cent of carbon.—Iron, containing as little as 2·3 per cent of carbon, still retains the properties of cast-iron, particularly the faculty of separating graphite, when allowed to cool slowly. With 2 per cent of carbon, iron is not forgeable, and scarcely so if it contain only 1·9 per cent.

(1) From Berichte der Ber. Acad. in J. Pr. Chem. XL, 229; Dingl. Pol. J. CIV, 39; J. Pharm. [3] XII, 139. Compare analyses of American cast- and bar-iron, by Svanberg in Berzelius' Jahresber. XXV, 198.

Carbon in iron.

With this quantity of carbon it is steel, though not of the weldable kind (cast-steel); even with so small a proportion of carbon as 1·75 per cent it is weldable only in a slight degree; the latter property increases as the hardness of the iron decreases. An amount of from 1·4 to 1·5 per cent of carbon in iron denotes the maximum of both hardness and strength. Iron containing 0·5 per cent of carbon is a very soft steel, and forms the boundary between the steel (i. e., iron which may yet be hardened) and malleable or bar-iron. These limits lie perceptibly higher if the iron be pure; and lower if it contain silicium, sulphur and phosphorus.

Phosphorus and Arsenic in Iron.—Schafhäutl(1) calls attention to the circumstance that arsenic and phosphorus are but seldom absent in cast-iron, bar-iron, and steel, a fact of which he has convinced himself by numerous analyses; he connects with this occurrence the observations lately made respecting the presence of arsenic in iron-ores and mineral waters, and considers this connection the more probable, as he, for the first time, succeeded in proving the presence also of tin and antimony in the different sorts of iron. Finally, he believes that the celebrated Dannemora iron and the capital Low-Moor iron of England, owe their quality to the arsenic they contain, and that the excellent quality of the Russian so-called C. C. N. D. iron (from Demidoff's iron works, at Nischnetagilsk), is owing to the presence of phosphorus.

Smelting of Copper-Ores.—A. Parkes(2) has taken out a patent for some improvements in the smelting of copper-ores (and similar sulphides). In the first part he recommends the use of gypsum, glauber-salt, sulphate of potassa, or heavy-spar, as fluxes in the smelting of the regulus.—In the second part of the patent he describes the reduction of the regulus by means of protoxide or carbonate of copper, the action of which is assisted by a flux [chloride or calcium or barium (!)].

Process of Precipitating Copper by Iron.—Important progress has been made in the smelting of copper-ores, by the invention of Rivot and Phillips(3), which is a modification of Napier's(4) process. The latter proposed, a few years ago, to precipitate the copper by a galvanic current from the ores fused in a graphite crucible; in order to effect this, he connected the negative pole of a battery with

(1) J. Pr. Chem. XL, 304.

(2) Chem. Gaz. 1848, 491.

(3) Compt. Rend. XXIV, 617; Dingl. Pol. J. CV, 187. Pelouze's Report thereon: Compt. Rend. XXV, 739; Dingl. Pol. J. CVII, 121; Bull. Soc. d'Enc. 1848, 352.

(4) Comp. Dingl. Pol. J. XCVII, 293.

Process of precipitating copper by iron.

the crucible, and the positive pole with an iron plate, plunged into the fused mass.—Rivot and Phillips found by numerous experiments, made upon this method in the *Ecole des Mines*, that iron precipitates the copper from the silicates in a high state of fusion without the aid of the galvanic current, exactly as it does from solutions of the salts in the cold. In endeavouring to apply this observation practically, they had, as a first step, to meet the obstacle, which arose from the large quantity of iron necessary for the precipitation. After having found that protoxide of iron, when in the state of silicate, is even more easily converted into sesquioxide by the oxidizing flame of the furnace than it is by exposure of aqueous solutions of its salts to the air, and that metallic iron has no action whatever upon the silicate (consisting of lime, iron and copper), produced by the fusion, before the whole of the iron contained therein has passed over into the state of protoxide, they conceived the happy idea of effecting the reduction to the greater part by coal, and of completing it by metallic iron. In this manner, a quantity of iron is required, amounting to only 15 per cent of the weight of the copper.

The following is the process as worked out by the inventors. The ore (pyrites), ground between mill-stones to a fine sand, is roasted in a furnace, and then heated until the sulphates are decomposed; in this manner the sulphur is almost completely expelled. The roasted ore, mixed with the proper quantity of flux and lime, is now smelted in a reverberatory furnace, with addition of coal in small fragments. The fusion, which must be effected rapidly, yields two products: reduced copper, and a supernatant mass of slag or silicate (the bath), which contains the rest of the copper in the combined state, amounting pretty constantly to from 2 to 2½ thousandths (per cent ?). It is this portion that is finally precipitated by iron bars, which are immersed obliquely; this part of the process takes three or four hours, with a charge of from 4 to 5 cwt. The slag, thus treated, contains still about 0·005 to 0·0065 of that metal; the copper contains 0·004 of iron and sulphur, from which it must be freed by refining. A saving of about 17 per cent in the cost of production, under equal circumstances, is calculated to be effected by this process.

Foreign Metals in Copper.—Max, Duke of Leuchtenberg(1), has subjected to a closer examination, the black precipitate, previously examined by him, which is formed at the anode in the decomposition of sulphate of protoxide of copper by the galvanic current. This

(1) Petersb. Acad. Bull. VI, 129; Dingl. Pol. J. CVI, 35.

Foreign metals in copper.

precipitate consists of sulphur, selenium (from the sulphuric acid), arsenic, tin (partly from the solderings), gold, silver, copper, and iron, all of which substances are derived from the copper, with the exception of those otherwise accounted for; 22 lbs. of this precipitate yielded, upon fusion with black flux, 8 lbs. of an alloy, containing in 100 parts, 90·2 of silver, 4·8 of gold, 2·2 of platinum (which had previously escaped observation), and 2·8 of metals convertible into slag in cupellation. This analysis furnishes a new proof of the great diffusion of the noble metals, particularly of platinum, and of their occurrence in copper-ores.—The same Prince has, at a later period(1), submitted an average sample of this deposit to a more minute analysis, and has found in 100 parts:

Sand	1·90	Platinum	0·44	Copper	9·24	Vanadium	0·64
Antimony	9·22	Gold	0·98	Iron	0·30	Sulphur	2·46
Tin	33·50	Silver	4·54	Nickel	2·26	Selenium	1·27
Arsenic	7·40	Lead	0·15	Cobalt	0·86	Oxygen	24·82

Tin.—Kersten(2) has examined several kinds of tin for the metals existing therein as impurities. According to earlier and to his own observations, the metals found are: iron, copper, arsenic, antimony; and but rarely zinc, lead, bismuth, molybdenum, tungsten, and manganese.

1. In tin from the Altenberg Zwitterstock, qualitative examination showed the portion soluble in hydrochloric acid to consist of: tin, iron, and a trace of manganese; and the insoluble portion of bismuth, and copper, with traces of arsenic, tungsten, and antimony, but no sulphur.

2. Peruvian tin; hard and brittle, greyish-white, possessed of slight lustre. The portion soluble in hydrochloric acid was found, by qualitative analysis, to consist of: tin, lead, and iron; the insoluble portion, of antimony, traces of copper and of arsenic.

By qualitative analysis, the two samples were found to contain in 100 parts:

No. 1.		No. 2.	
Pure tin	97·83	Tin	93·50
Residue insoluble in hydrochloric acid	1·90	Antimony with traces of copper and arsenic	3·76
Iron	0·11	Lead	2·76
	99·84	Iron	0·07
			100·09

(1) Petersb. Acad. Bull. VII, 218; Dingl. Pol. J. CXI, 136; J. Pr. Chem. XLV, 460.

(2) Dingl. Pol. J. CVIII, 25.

Extraction of Silver without Mercury.—Two new methods have been introduced in Mexico, for working silver-ores without mercury, which promise to supersede the present expensive process(1). They are the invention of a German, Ziervogel and were, to the best of our knowledge, first practically applied in the county of Mansfeld. The first method consists in roasting the ores with chloride of sodium, dissolving the chloride of silver thus produced in a hot solution of chloride of sodium, and precipitating by metallic copper. —According to the second method, the ores are converted into sulphates by roasting, the latter dissolved and precipitated by metallic copper.

Extraction of silver without mercury.

Silvering in the Moist Way.—Stein, of Dresden(2), has described a simple and easy method of silvering in the moist way (without galvanism). 1 part of nitrate of protoxide of silver and 3 parts of cyanide of potassium (prepared according to Liebig's process), are triturated together, with the addition of sufficient water to form a moderately thick paste. This is rubbed with a woollen rag rapidly and uniformly upon the article to be silvered, when the silver coating will appear spontaneously. This plating is stated to be very beautiful, it does not, however, adhere firmly enough to endure strong friction with tripoli or chalk.

Roseleur and Lavaux(3) recommend for the same purpose, with the same mode of application, a bath, consisting of 100 parts of sulphite of soda and 15 parts of any silver-salt. This bath acts upon the article to be plated, consisting of copper or its alloys, partly by the substitution of silver for copper, partly by the reduction of silver by the sulphurous acid. This mode of plating, which is but of slight durability, is only adapted for small trinkets.—They recommend as a bath for gilding, by mere immersion, a solution of terchloride or teroxide of gold in an alkaline pyrophosphate. The articles are said to be gilt by this means almost instantaneously, while a similar bath of an alkaline tribasic phosphate, has no gilding properties whatever.

Gilding.—The gilding of the wheels of watches has hitherto been attended by insurmountable difficulties, as, by the known methods the steel pivots were either gilt likewise, or injured in the process. The latter is particularly the case in the method hitherto practiced of amalgamating for the purpose of wash-gilding.

(1) Moniteur Industriel 1847, 1165; Dingl. Pol. J. CVI, 75.
(2) Pol. Centr. 1847, 11. Lieferung; Dingl. Pol. J. CV, 27.
(3) Technologiste 1847, 341; Dingl. Pol. J. CV, 29.

Gilding.

Ph. Plantamour(1) has succeeded in preparing an amalgamating fluid which, being of alkaline reaction, cleans and amalgamates the wheels simultaneously, without attacking the steel pivots in the slightest degree. He dissolves mercury in nitric acid, and adds ammonia to the solution, until the precipitate at first formed is redissolved. This rapidly takes place if an excess of acid be present, the double salt formed being easily soluble in the resulting nitrate of ammonia. The wheels are immersed in this solution for some minutes without farther preparation; the excess of ammonia removes the fatty impurities on the surface, and the amalgamation of the yellow metal ensues. The amalgamated objects are covered, whilst wet, with gold-amalgam, and heated over a spirit-lamp, most appropriately upon a drum furnished with openings for the insertion of the pivots. In this manner the strong heating and consequent softening of the steel parts is avoided.

Tin-Plating.—The usual coating of sheet-iron with tin has the disadvantage of being too soft and easily fusible; these faults may be avoided, according to Budy and Lammatsch(2), by previously alloying the tin with $\frac{1}{16}$ of nickel. The higher price of the alloy is said to be compensated for by a saving of one half in the quantity of tin employed.

Coating of Glass and Porcelain with Copper.—Elsner(3) has published some improvements of the process proposed by Mohr, for covering chemical porcelain or glass apparatus with a coating of metallic copper, by galvanism. They consist first in replacing the expensive copal-varnish (by which the conducting coating is fastened upon the object) by a cheaper varnish, made of 2 parts of asphaltum and 1 part of mastic, fused together and dissolved in oil of turpentine to syrupy consistence. He also replaces the conducting coating of gold-leaf, bronze-powder, or brass-filings, by graphite-powder; finally, in order to prevent the copper coating coming off from any vessels of a flat open form (as it does, for instance, almost invariably from evaporating dishes), Elsner roughens the surface of the vessel by etching it with hydrofluoric acid; smaller articles are etched in the usual way, and larger vessels by covering the surface with a paste of fluor-spar and sulphuric acid.—If the object be to manufacture copper basins by this process, the glass or porcelain

(1) Arch. Ph. Nat. V, 60; Compt. Rend. XXIV, 784; Dingl. Pol. J. CV, 34; J. Pharm. [3] XII, 297.

(2) From the Brevet d'Invention in Pol. Centr. 1848, 530; Dingl. Pol. J. CIX, 315.

(3) Verh. Gew. Bef. Pr. 1847, Novbr. u. Decbr. 174.

vessels being consequently only used as moulds, the etching is of course omitted, and finely divided copper (precipitated from a solution of copper by zinc) employed instead of the graphite, in order that a bright gildable surface may be obtained. Coating of glass and porcelain with copper.

According to W. Johnson(1), a solution of gutta percha in benzole may be employed with advantage for covering objects of glass, porcelain, &c., with a conducting layer of graphite for the purpose of electrotyping.

Coppering of Iron.—The copper coating on iron, as produced by immersion of the latter in sulphate of copper, is known to be of a very non-adherent nature; it may, according to H. Reinsch's(2) statements, be obtained polishable, very durable, of any thickness, and consequently fit for any practical application, by the following process. A bath is prepared by adding to hydrochloric acid, diluted with 3 volumes of water, a few drops of solution of sulphate of copper, into which is immersed for a few seconds, the iron, previously scoured bright with bitartrate of potassa and charcoal-powder. The metal is then rubbed clean with a cloth, in order to separate the iron, some more solution of sulphate of copper added to the bath, and the iron again introduced; this mode of proceeding is continued until the coating has attained the requisite thickness.

Coating of Iron and Steel with Lead.—Parkes(3) has described a new method for coating iron and steel with lead. The scoured pieces of metal are dipped into a bath of one of the following alloys: 9 parts of lead and 3 of antimony, or 9 of lead, 1 of tin and 1 of antimony, the surface of which is covered with fused chloride of barium, or chloride of sodium, or a mixture of both.

Etching Fluids for Copper and Steel.—A great evil, in etching on steel or copper with nitric acid, is the disengagement of gas. To remove this, Schwarz and Böhme(4) recommend the following etching liquids.—*For steel:* 10 parts of fuming hydrochloric acid (of 40 per cent) diluted with 70 parts of water are mixed with a boiling solution of 2 parts of chlorate of potassa in 20 parts of water. The liquid has a slight odour of chlorine, and is diluted, before application, with from 100 to 200 parts of water.—*For copper:* 2 parts of iodine and 5 of iodide of potassium are dissolved in 4 parts of water, or in double that amount when less powerful action is

(1) Pharm. J. Trans. VIII, 84.
(2) Jahrb. Pr. Pharm. XVI, 337.
(3) Chem. Gaz. 1849, 492.
(4) Ann. Ch. Pharm. LXVI, 63; Dingl. Pol. J. CIX, 313.

Separation of gold by sulphuric acid.

required.—Both solutions are said to answer all purposes, even for the very finest lines.

Parting of Gold by Sulphuric Acid.—The parting of gold by sulphuric acid has been scientifically elucidated by M. Pettenkofer(1), in an excellent treatise, which has added considerably to our knowledge on this subject, both by the discovery of platinum in the gold, and by the observation of certain phenomena which prevent the separation of the last portions of silver by sulphuric acid.

The quantity of gold in 16 parts of alloy, should, as is well known, be between 3 and 4 parts, and the silver should amount to at least $\frac{5}{8}$ of the alloy, in order that the parting may be effected most advantageously. That the amount of gold should have this higher limit might be anticipated; it is much more remarkable that there is likewise, as shown by the experience of all practical men, a minimum amount of gold; the separation of the silver by means of sulphuric acid presenting greater difficulties, as the amount of gold falls below this limit. A similar deportment had previously been observed in the parting of gold by nitric acid. Pettenkofer made his observations in the Refinery, at Munich, where the gold of the Kronenthaler (0·00007 of their weight) is separated by dissolving the coins in sulphuric acid, the operation being performed in cast-iron vessels. The parting proceeds at first rapidly, until the fineness of the gold equals about 958 to 960 thousandths; this is raised to 970—972 thousandths, only by long continued boiling with a large excess of acid; the separation can, however, never be carried farther than this. A sample, employed in a special experiment, required boiling with acid eight times; and even after four additional operations, the fineness could only be raised $\frac{1}{4}$ of a thousandth. The method resorted to in practice, is to fuse the spongy gold with nitre, to alloy the regulus once more with silver, in convenient proportions, and to submit it then to a second parting; this proceeding, however, often leads to the same difficulty.

Small quantities of sulphate of lead, basic sulphate of sesquioxide of iron, and traces of sulphide of copper, may be separated from the gold of the first parting by digestion with carbonate of soda, washing, and treatment with nitric acid. The average of several determinations showed the residue to consist of 97·0 per cent of gold, 2·8 of silver, and 0·2 of *platinum*; by ignition in hydrogen, only traces of chlorine and sulphur were detected; neither phosphorus nor arsenic could be

(1) Dingl. Pol. J. CIV, 118.

found in the solution in nitro-hydrochloric acid. The silver is therefore contained in the spongy gold, in the reguline state. It cannot be extracted to the smallest amount either by boiling sulphuric or boiling nitric acid. Not a trace of chloride of silver is dissolved by ammonia, after treatment with solution of sesquichloride of iron. It is a still more remarkable fact, that sulphur may be repeatedly distilled over this pulverulent gold without any sulphide of silver being formed; most startling, however, is its deportment with boiling sulphuric acid, to which powdered bichromate of potassa has been added; considerable quantities of gold are dissolved in this case, with formation of sesquioxide of chromium, while neither the silver nor the platinum are attacked. Parting of gold by sulphuric acid.

Pettenkofer draws from these phenomena the conclusion, that the silver is retained in the spongy gold with properties differing from those it possesses in its normal state; he does not, however, hazard an opinion, as to whether the silver is present in an amorphous condition, differing from that of ordinary silver, or in the form of a definite chemical alloy, which is decomposed only with difficulty; the latter is not very probable, as the spongy gold would contain 1 equivalent of silver to 19 equivalents of gold.—The above condition of silver is brought about by gold alone, but is heightened by the amount of platinum present.

According to Pettenkofer's observations, the alkaline bisulphates are the only efficient agents for dissolving this silver; this observation is of great value for the practical refiner. Sulphuric acid, which boils at 326°, being added as a second equivalent to the neutral sulphate of an alkali, may be brought to act upon the metal at a red heat. Spongy gold, freed from silver, so as to contain only 3·0 per cent, retained after this new treatment not more than 0·6 per cent of silver. Bisulphate of soda is preferable for this purpose, on account of its solubility and low price. The best plan is to mix the spongy gold with $\frac{1}{4}$ of its weight of dry sulphate of soda in an iron vessel, to add the second equivalent (0·7 of the weight of the glauber-salt) of hydrate of sulphuric acid, and then to heat until the salt enters into a state of fusion. Sulphate of protoxide of silver is formed, with evolution of sulphurous acid (and hydrochloric acid, from the adhering chloride of sodium), sulphuric acid being volatilized; the mass is to be kept stirred, to prevent as much as possible its conglomeration. The alkaline sulphate, by this operation, becomes nearly neutral; in order to dissolve the remainder of the silver, it is only necessary to repeat the process; the application of heat should, however, only be continued till about one-half of the bisulphate has

Parting of gold by sulphuric acid.

been converted into the neutral salt. For the final separation of the gold from the mass, the latter is boiled as usual with sulphuric acid; the sulphates of soda and silver are dissolved; the residue is washed, dried, and fused with nitre. The operation, with a quantity of from 12 to 14 ounces, occupies from $\frac{1}{2}$ to $\frac{3}{4}$ of an hour, and yields, after the first fusion, gold of 994 thousandths of fineness; after the second, of from 998 to 990 thousandths; its success depends mainly on the proportion of glauber-salt employed, and the temperature, which should not quite attain a red heat.

By the above observations, Pettenkofer was led to submit the so-called quartation to an experimental critique. He arrived at the following principal conclusions: 1. That in the parting by nitric acid, it is not absolutely necessary to have the silver and gold in the proportion of 3 : 1, but that a reduction of the amount of silver added, to as low a proportion as 1·75, yields still accurate results (this had been previously ascertained by Kandelhardt and Chaudet, with respect to proportions corresponding within certain limits to $Au Ag_2$). 2. That the gold, parted by quartation, is the richer in silver, the higher the amount of the latter rises above the stated maximum proportion.

Pettenkofer's discovery of the presence of platinum in the spongy gold affords, moreover, an explanation why this product is never sufficiently fine and soft, unless previously fused with nitre, platinum being well known to be easily oxidized by fusing nitre. Together with the platinum, however, a very appreciable quantity of gold is taken up by the slag; for, although gold by itself is but very slightly attacked by nitre, in the presence of platinum it is acted upon in a very high degree. It may also happen sometimes that a portion of the platinum, protected by the presence of the silver, remains in the gold (to the amount of from 1 to 2 thousandths). The slags resulting from the fusion with nitre, yield, after treatment with water, a finely divided grey powder, containing alumina, silicic acid and potassa, some protoxide of lead, protoxide of copper, and sesquioxide of iron, besides binoxide of platinum, teroxide of gold, and an admixture of metallic gold. It has hitherto been the custom to levigate this powder (the washed slag), in order to obtain this reguline gold. The residues, after levigation, still contain, however, according to Pettenkofer, from 19 to 20 per cent, and often a greater amount, of gold, from 2·5 to 3·5 per cent of platinum, and some silver, the presence of which substances were not suspected, on account of the lightness of these residues, and because they could not be removed by amalgamation. An assay, made according to the author's method,

Parting of gold by sulphuric acid.

with acetate of lead (comp. Dingl. Pol. Journ. C, p. 459), of 5 grammes of the washed and dried slag-residue, yielded a lead-button, which left on the cupel a button, containing platinum, weighing from 1·5 to 2 grammes. As in a refinery, which yields from 400 to 500 ounces of gold per annum, several ounces of this metal, and from 2 to 3 ounces of platinum must be lost in these slags, it is important that some new method should be devised for working them up; Pettenkofer has promised to direct his attention to this point.

Pettenkofer concludes, from the extensive information which he has been able to collect, that all silver in circulation (with the exception of that obtained in the refineries) contains platinum; this is more particularly proved by the presence of platinum in older coins (Brabant thalers), which are derived from a period, when no kind of application had been made of platinum.—From the slight affinity of mercury for platinum, the latter must remain in the residues, after the last processes of extracting by amalgamation; Pettenkofer obtained, in fact, from two samples of this kind 0·017 and 0·01 of platinum.

It need scarcely be specially mentioned, that the value of the silver derived from these processes is raised considerably ($5\frac{1}{2}$ per cent) by the platinum contained therein.

Hydrostatic Silver-Test.—Karmarsch(1) has endeavoured to substitute, in those cases in which the determination of silver by cupellation or in the moist way is impracticable (for want of the necessary apparatus or sufficient dexterity of manipulation), a simpler test which at the same time is more accurate than that of the touchstone; namely, the *hydrostatic test.* This test is intended to indicate the amount of pure silver in an alloy of this metal with copper, by the mere determination of the specific gravity of the alloy. In his preliminary experiments on the circumstances that affect the specific gravity of silver-alloys, Karmarsch found that copper and silver expand on being alloyed; in fact, that 13 carat fine silver expands $\frac{1}{3}$ per cent, 11 carat fine silver $\frac{1}{6}$ per cent, and 9 carat fine silver $\frac{1}{4}$ per cent; and that rolled fine silver, on being coined, increases in density $\frac{1}{8}$ per cent; 9 carat fine silver $\frac{1}{100}$ per cent, and the remaining silver alloys in proportion to the amount of fine silver they contain; generally the density of an alloy increases in proportion to the mechanical pressure to which it was subjected; this increase of density varies according to the fineness of the silver, and compensates

(1) Mittheilungen des Gewerbvereins für Hannover, 1847, 55. Lieferung (comp. II. p. 285, sub 1.)

Hydrostatic silver-test.

only in a small degree for the expansion arising from the alloying. This circumstance alone is sufficient to render the hydrostatic test very uncertain, and has induced the author to abstain from applying it to cast and slightly worked silver, and to employ it exclusively for coined silver; this is just a case, however, in which such a test is the least needed. Larger articles are also excluded on account of the space they occupy (if circumstances do not allow of their being cut up), as well as impure or soldered articles (on account of the foreign metals they contain). To ensure accuracy, the absence of parts that do not contain silver, and, strictly speaking, even of frosted surfaces is requisite.

If, in 288 grains (= 1 mark) of copper, 1 grain be replaced by pure silver, the spec. grav. of the alloy will increase $\frac{1}{288}$th of the difference between the spec. grav. of the silver and that of the copper(1). Let the spec. grav. of the copper = K, and this increase = p, then the spec. grav. L of the alloy will be, in the case under consideration, $L = K + p$, in general $L = K + n\,p$, n representing the fineness in each case, and provided that no condensation takes place. The values of K and p cannot be determined from the known specific gravities of silver and copper; partly because these magnitudes are not sufficiently well established, and partly on account of the condensation. These considerations have induced Karmarsch to perform a series of weighings of alloys of different, but accurately known, degrees of fineness; he uses the average numbers obtained, and the specific gravities forming the limit on either side, for deducing the values of K and p for the two metals, in the state in which they exist in the alloy. In this manner he finds, by the method of least squares, $K = 8{\cdot}814$ and $p = 0{\cdot}000579$. The above equation, after introduction of these values, gives: $n = \frac{L - 8{\cdot}814}{0{\cdot}000579}$, from which the author has constructed a table for ordinary use. The formula, tested with known alloys, exhibits an average error of 2·26 grains $= \frac{8}{1000}$. With coined silver the calculated results seldom vary from the cupel-assay more than 3 grains, *i. e.*, $\frac{10{\cdot}4}{1000}$. The value of the method may be judged of accordingly.

(1) This is by no means the case, but irrespectively of the condensation or expansion ensuing, the volume will decrease by the difference between the volumes of 1 grain of copper and 1 grain of silver. The calculation upon this basis furnishes results very different from those obtained by Karmarsch's formula.

Another part of the observations of Karmarsch(1) has reference to the wear of silver-alloys. The result arrived at is, that coins should not be above 14 carat fine; they are certainly more durable when below 12 carat fineness, but are not admissible on account of their colour. Hydrostatic silver-test.

Gold and Zinc Alloy.—In England, the discovery that gold of 12 carat and less, when alloyed with zinc instead of silver, possesses the colour of certain legal gold-silver alloys, has been used for fraudulent purposes to a great extent(2).

Peruvian Gold Alloy.—How(3) found in an alloy from the tomb of an Inca in Peru 38·93 gold, 54·82 silver, and 5·80 copper.

Grecian Bronzes.—Erdmann(4) has had analyses made of a number of Grecian bronze coins, of undoubted genuineness collected and determined on the spot by Prof. Ross, of Halle. The results (see annexed table, from 1 to 8) confirm the statement made by Göbel, that zinc exists in the bronze coins of the Romans, but is never found in those of Greece and her colonies.

No. 1. Ancient-Attic, analysed by A. Mitscherlich. No. 2. Athenian, from the Roman period, analysed by the same and by E. Schmid. No. 3. Athenian, analysed by R. Wagner. No. 4. Coin of a Macedonian King, analysed by O. Monse. No. 5. Coin of Alexander the Great, analysed by E. Schmid. No. 6. Coin of the same king, analysed by R. Wagner. No. 7. Attic coin, analysed by Ulich. No. 8. Likewise Attic, analysed by Heldt.

Constituents.	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	No. 7.	No. 8.
Copper . . .	88·46	76·41	83·62	87·95	95·96	86·76	87·89	88·81
Tin	10·04	7·05	10·85	11·44	3·28	10·24	11·58	9·61
Lead	1·50	16·54	5·53	—	0·76	2·31	—	—
Iron	—	—	—	—	—	—	0·27	1·18
Gold	—	—	—	—	trace	trace	—	—
	100·0	100·0	100·0	99·39	100·0	99·31	99·74	99·60

Chinese Bronzes.—Stan. Julien(5) has given an account of the nature of some alloys used in China, and of the method of working

(1) Polytechnische Mittheilungen of Karmarsch and Volz, 3. Jahrgang 1846, 3. and 4. J. Pr. Chem. XLIII, 198; Dingl. Pol. J. CVIII, 278.
(2) Technologiste 1847, 532; Dingl. Pol. J. CVI, 155.
(3) Chem. Gaz. 1846, 495; J. Pr. Chem. XLIII, 318.
(4) J. Pr. Chem. XL, 374.
(5) Compt. Rend. XXIV, 1069; J. Pr. Chem. XLI, 284.

Chinese bronzes.

them. Alloyed copper alone is employed, but not the pure metal; the alloy with calmine may be hammered while hot, but the alloy with Japanese lead must be hammered in the cold. The alloy with a certain quantity of arsenic (pé-tong) is white; it is wrought with more difficulty than brass, and is chiefly in use with the rich. For musical instruments the Chinese alloy the copper with $\frac{1}{5}$ tin.—It is customary to soft-solder utensils with tin, and hard-solder them with bell-metal (*i. e.*, copper with $\frac{1}{4}$ tin), which is applied previous to fusing, with a paste of rice.—Cymbals are beaten out upon the ground(?), without the aid of an anvil; they are made to possess a sharp or deep tone, according to the size of the hollow.

Bronzing by Galvanism.—Brunel, Bisson, and Gaugain(1) publish the following process for covering metals with bronze or brass, by galvanism, as superseding the use of cyanogen-compounds proposed in 1841: 50 parts of carbonate of potassa, 2 parts of chloride of copper, 4 parts of sulphate of zinc, and 25 parts of nitrate of ammonia are dissolved together in water. The article to be bronzed is connected with the negative pole of a Bunsen's battery, and a plate of brass or bronze employed as the positive, decomposing pole. According to Becquerel's testimonial, the bronzed articles produced in this manner will bear comparison with the finest ordinary bronze.

Bell-Metal.—A. Heyl(2) has analysed the metal of two bells of the Darmstadt chimes, cast in 1670, by Peter Hemmony, namely: 1. of the note of B above the first added line, and 2. of the note of C on the second added line (treble clef).

	Tin.	Lead.	Copper.	Nickel.	Iron.	Arsenic.	in 100 parts.
No. 1	21·67	1·19	73·94	2·11	0·17	trace	
No. 2	21·06	2·14	72·52	2·66	0·15	trace	

Chinese Copper-Alloys.— H. Onnen(3) has examined the following copper alloys (the nickel was separated from zinc according to Smith's method): 1. Chinese copper, or pack-fong, a large cake of light-yellow colour. 2. The same, a ring, of varying yellow colour. 3. Without name, beautifully red. 4. Chinese copper, first kind, fine red colour. 5. Chinese copper, second kind, copper-red. 6. Chinese copper, third kind, similar to No. 5. 7. Named like

(1) Moniteur Industriel 1848, No. 1227 Dingl. Pol. J. CVIII, 20; Bull. Soc. d'Enc. 1848, 260.

(2) Ann. Ch. Pharm. LXII, 86.

(3) Scheik. Onderz. IV, 517; J. Pr. Chem. XLIV, 242.

No. 4, copper-red. 8. Named like No. 5, but blackish-red. 9. Like the foregoing one. Chinese copper alloys.

Tin was not detected.

Number . . .	1.	2.	3.	4.	5.	6.	7.	8.	9.
Spec. grav. . .	8·57	7·84	8·31	8·93	8·70	8·45	8·58	8·70	8·46
Silver . . .	0·12	0·14	0·14	0·505	0·07	0·07	—	—	—
Copper . . .	87·54	85·09	98·49	97·79	82·21	62·49	97·12	92·65	93·48
Iron	1·17	4·08	0·01	0·21	0·19	0·40	1·28	0·10	4·43
Nickel . . .	11·84	9·49	1·19	1·35	0·71	0·74	1·84	2·11	0·46
Cobalt . . .	0·44	1·16	—	—	—	—	—	—	—
Sulphur . . .	0·10	0·49	—	—	—	—	0·30	0·06	0·47
Zinc	—	—	—	—	17·56	35·84	—	—	—
Lead	—	—	—	—	—	—	—	5·75	—

Copper-Amalgam for Dentists.—The French dentists have for some time past made use of a copper-amalgam for stopping teeth. Pettenkofer has made the following valuable observations respecting this remarkable substance(1).

The surface of this amalgam, which is sold in small rolls of about 5 or 6 grms. weight, is covered with a greyish tarnish; its hardness is much greater than that of bone, and its cohesion and solidity are considerable. It is of a fine granular crystalline structure. A sample was found, on analysis, to contain 0·3 of copper and 0·7 of mercury. This amalgam has the remarkable property of swelling up when heated nearly to the boiling-point of water, drops of mercury exuding, which disappear again upon the cooling of the substance. If a piece thus heated, be rubbed up in a mortar, a plastic, mouldable mass, like poor clay, is obtained, the consistence of which may, by continued kneading, be increased to that of fat clay. If the moulded mass be left for ten or twelve hours, it hardens, acquiring again its former properties, without altering its specific gravity, *i. e.*, without changing in volume, a peculiarity which is very important for its practical application. Hence the stopping, after it has hardened, remains tightly fixed in the hollow of the tooth. The softening and hardening, just described, may be repeated many times with the same sample.

Pettenkofer ascribes these phenomena to a state of amorphism, into which the amalgam passes from the crystalline solid condition, in the process of softening; the liberation of mercury, however,

(1) Dingl. Pol. J. CIX, 444; Repert. Pharm. [3] II, 79. The spongy gold mentioned I. p. 345, is likewise used for stopping teeth.

Copper-amalgam for dentists.

appears to point also to some chemical change. According to Pettenkofer's experiments, all copper-amalgams containing between 0·25 to 0·33 of copper, exhibit the same behaviour.

Pettenkofer recommends, as the best method of preparing this amalgam, that a crystalline paste of sulphate of suboxide of mercury (prepared by dissolving mercury in hydrated sulphuric acid at a gentle heat) be saturated under water, at a temperature of from 60° to 70°, with finely-divided reguline copper (prepared by precipitation from sulphate of copper by iron). One portion of the copper precipitates the mercury, with formation of sulphate of copper; the other portion yields with the mercury an amalgam; 100 parts of dissolved mercury require the copper precipitated, by iron, from 232·5 parts of sulphate of copper.—As, in dissolving the mercury, the protoxide is easily formed, instead of the suboxide, particularly if too high a temperature be employed, it is advisable, in order to avoid an excess of mercury in the amalgam, to take 223 parts of sulphate of copper, and to add to the washed amalgam, which is kept stirred, a quantity of mercury, in minute portions, corresponding to the amount of suboxide contained in the mercury-salt, until the whole has become sufficiently plastic. (This amalgam is obtained easily and rapidly, by moistening finely-divided copper with a few drops of a solution of nitrate of suboxide of mercury and then triturating the metal with mercury in a warmed mortar. The rubbing must be continued for some time, and may be carried on under hot water; mercury is added until the required consistence is attained).—The amalgam is not affected by hot water, nor by dilute acids or alkalies, alcohol or ether, and may be applied for various other purposes, f. i., as cement, &c.

Copper containing Nickel.—G. F. Wille has undertaken, for the Hessian Board of Mines, the analysis of various smelting-products, containg nickel(1). These products are:

1. Coarse copper (black copper), from Richelsdorf, obtained by fusing together the scoriæ resulting in the refining of the copper at that place. 2. Refined copper, obtained from this black copper. 3. Another specimen, of the same kind, obtained from the coarse copper of the Friedrichs works, at Richelsdorf; highest disk. 4. The same, second disk. 5. Refined copper from the common black copper of the Friedrichs works; highest disk. 6. The same, second disk. (The following disks of 3. and 4. contain only traces of nickel).

(1) J. Pr. Chem. XLII, 189.

	1.	2.	3.	4.	5.	6.
Copper	71·0	76·8	83·25	96·98	83·00	87·75
Iron	11·0	4·0	3·40	0·20	0·80	0·30
Nickel	10·0	13·6	12·82	2·99	12·10	7·85
Cobalt and arsenic.	—	—	—	—	trace	trace
Oxygen	—	—	—	—	3·70	2·58
Sulphur	7·0	5·1	1·19	0·10	—	—
Loss	1·0	0·5	—	—	0·40	1·52
	100·0	100·0	100·66	100·27	100·00	100·00

Copper containing nickel.

Compare with these, former observations on the amount of nickel in copper, by Genth(1). Considerable quantities of nickel have for some years past been obtained, as a secondary product, in the refining of copper, at the Saxon works, at Grünthal.

Nickelspeiss.—R. F. Marchand(2) has published an analysis, made by Schneider, of nickelspeiss, remarkable for the considerable quantity of bismuth which it contained. The separation of the cobalt and nickel was effected according to H. Rose's method:

Sulphur	2·182	Carried over	51·659
Bismuth	13·185	Cobalt	3·262
Arsenic	35·319	Nickel	43·248
Iron	0·973	Copper	1·568
	51·659		99·737

Smelting-Products containing Nickel.—C. Schnabel(3) has communicated the following analyses of smelting-products containing nickel:

	Refined copper containing nickel. Isabella Foundry, near Dillenburg.	Nickel from Henkel of Cassel; made from Nickelspeiss.
Copper	97·49	7·96
Nickel	0·69	89·35
Iron	0·31	2·69
Sulphur	0·14	—
Silicium	1·35	—

German-Silver.—The English alloy, called German silver, has been analysed by Louyet(4) and by Elsner(5). Nos. 1 to 3 are used in Birmingham for utensils which are afterwards plated; No. 4, from

(1) J. Pr. Chem. XXXVII, 193. (2) J. Pr. Chem. XLIII, 317.
(3) Pogg. Ann. LXXI, 516; Dingl. Pol. J. CV, 238.
(4) Technologiste Decbr. 1846; Dingl. Pol. J. CIII, 234.
(5) From the Verhandlungen des preussischen Gewerbevereins, in Dingl. Pol. J. CIII, 155.

German-silver.

Sheffield, is used for stay-busks, and is remarkable for its peculiar elasticity. 100 parts of the metal contained :

	Louyet.			Elsner.
	No. 1.	No. 2.	No. 3.	No. 4.
Copper	63·34	62·40	62·63	57·4
Zinc	17·01	22·15	26·05	25·0
Nickel	19·13	15·05	10·85	13·0
Iron	trace	trace	trace	3·0
Loss	0·52	0·40	0·47	1·6

Fusing-points of various Alloys.—Thomson(1) has determined the fusing-points of alloys of lead, tin, bismuth, and zinc.—The alloys of lead and tin gave the following results :

Ratio of the equivalents.	Spec. grav.		Fusing-point.
	found.	calculated.	
Pb + Sn	9·288	9·899	182·2°
Pb + 2 Sn	8·688	9·209	182·8
Pb + 3 Sn	8·549	9·002	182·8
Pb + 4 Sn	7·850	8·545	190·0

In all cases, therefore, there is expansion and a decrease of the fusing-point; the mean of the fusing-points of the two metals, observed separately, being 273·6°.—The alloys Pb + Bi and Pb + 2 Bi had the spec. grav. 10·831 and 10·509, while the calculated mean spec. gravities are 10·580 and 10·328; in these cases, consequently, a contraction takes place. The fusing-point of the former alloy is 134·3°, that of the latter 128·2°; the mean of the fusing-points of the two metals, observed separately, is 288·6°.—These alloys are fine and white, but brittle. The alloys of tin and bismuth are similar.

	Spec. grav.		Fusing-point.
	found.	calculated.	
Bi + Sn	8·709	8·972	137·8°
Bi + 2 Sn	8·418	8·513	134·4

The alloys of tin and zinc, which are white, malleable, and similar to pewter, gave the following results :

	Spec. grav.		Fusing-point.
	found.	calculated.	
Zn + Sn	6·427	7·181	195·3°
Zn + 2 Sn	7·231	7·222	196·5

(1) Verh. Gew. Bef. Pr. 1848, 45, (in abstr.) from Proceed. Phil. Soc. Glasgow.

The alloy, Sb + Pb, is white, brittle, and has a spec. grav. lower than the mean of its constituents; Sb + Sn is very brittle, its spec. grav. is above the calculated number.

Manufacture of sulphuric acid.

Manufacture of Sulphuric Acid.—The well-known method of manufacturing sulphuric acid in leaden chambers is considered by practical men to be the best adapted for operations on a large scale, and is now exclusively in use. The advantages, however, of this process are counterbalanced, to a certain extent, by the necessity which it involves of apparatus, equally expensive in its erection and maintenance. But the desideratum of a simpler and cheaper practical method does not appear to be satisfactorily met, by either of the inventions upon which we have to report.

One of these is a method devised by Schneider(1), for obtaining sulphuric acid from crude sulphur, in a simple, cheap apparatus, by means of "peculiarly prepared pumice-stone," whereby the necessity of leaden chambers, or the co-operation of the oxides of nitrogen, is obviated. This invention has attracted great attention in the manufacturing world, more particularly in consequence of the recommendation of MM. Payen, Pelouze, and Dumas, the official reporters of the Academy in Paris. In the description of the process published by Schneider, the expenses of the apparatus are calculated at less than one half of the cost of leaden chambers requisite for the manufacture on an equal scale; the specification is copious in the less important details, and, on the contrary, laconic and obscure in the most essential points; the "peculiar" preparation of the pumice-stone is altogether passed over in silence. The otherwise very minute design of the apparatus is likewise unintelligible, on account of the sectional and ground-plans not being in correct relation to each other, according to the rules of drawing. The apparatus consists of a system of wide earthenware tubes, connected by bent joints, and opening into a reservoir after several reduplications. A mixture of sulphurous acid and air passes from a burner into one end of this range of tubes; the current of gas is made to pass not through but over the pumice-stone, which is exposed in flat vessels throughout the entire length of the tubes, but without filling the bore; a jet of water flows in at each of the bends, and is distributed by means of auxiliary

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(1) Bull. Soc. d'Enc. 1848, 78; Dingl. Pol. J. CVII. 159, 363; complete description and drawings in Bull. Soc. d'Enc. 1848, 372; Dingl. Pol. J. CIX, 354.

Manufacture of sulphuric acid.

pipes over the various vessels containing the pumice-stone, from which it removes the sulphuric acid, and then flows downwards into the reservoir. The manner in which the auxiliary tubes act is quite unintelligible, both from the specification and from the drawing.

We might conjecture the preparation of the pumice-stone to consist of platinization; the means employed by Schneider would then be a species of cheap spongy platinum. So much is certain, that the slight efficacy of pumice-stone is very perceptibly increased, by coating it with 2 per cent of platinum. As far as we can learn, however, Schneider denies the co-operation of this metal; he sells his process as a secret, but as he declines to convince the purchaser, by ocular demonstration, of the efficacy of his apparatus on the large scale, before payment of the stipulated sum, we may be still a long time before it is in our power to report farther on this subject, and must, therefore, leave it undecided, whether Schneider's invention be one of those intended rather for sale, than for a practical or useful object. It has, as yet, met with scarcely any application.

A patent has been granted in England to Tilghman(1), for a process in which the crude sulphur, used in the manufacture of sulphuric acid, is replaced by gypsum. The patentee exposes to a strong red heat fragments of gypsum, contained in an earthenware cylinder, coated inside with magnesite, and placed in a perpendicular position in the furnace, steam being allowed to enter at the bottom, through a system of red-hot earthenware pipes; the gaseous products of decomposition (namely—oxygen, sulphurous, and sulphuric acids) pass out at the upper end, into the leaden chambers. He states that caustic lime remains in the retort.—This decomposition does not succeed on a small scale, even at a bright-red heat. The process, if at all practicable, is likely to be more expensive than the employment of crude sulphur.

Tilghman treats anhydrous sulphate of magnesia in the same manner; the sulphates of strontia and baryta are worked according to the same principle, by being heated on the hearth of a reverberatory furnace, through the roof of which the steam-pipes are introduced.

Soda-Manufacture.—The conversion of Glauber's salt into soda, on the large scale, has, since Leblanc's invention, gradually attained an enormous extension; a number of other branches of industry dependent on the permanent necessities of man, and not on fashion,

(1) Rep. of Pat. Inv. 1847, 160; Dingl. Pol. J. CVI, 196.

Soda-manufacture.

have become its tributaries. It is remarkable, however, that the chemical rationale of the manufacture of soda, should have remained so totally neglected by chemists during the last twenty years, although we were far from possessing a clear insight into its nature; we have, therefore, the more occasion to rejoice that very active attention has been paid to it in the last two years. Our thanks are chiefly due to J. Brown(1) and B. Unger(2) for their investigations, which are interesting both in a practical and in a theoretical point of view. While Brown limits his research exclusively to the practical part of the subject, and is chiefly engaged in determining the chemical constitution of all the products occurring in the course of the soda-manufacture, B. Unger pays more attention to the purely scientific part of the question, with a view to elucidate the theory of the transformation of the Glauber's salt into soda.

Brown commences with the fundamental natural product, chloride of sodium, and compares with it the Glauber's salt resulting from its decomposition.

The chloride of sodium is derived from the salt-brines of the new red-sandstone, in the county of Cheshire, in the north of England, from which the soda-manufactories of this country are almost exclusively supplied. He found:

	In chloride of sodium.	In the Glauber's salt prepared therefrom.
Chloride of sodium . . .	93·161	1·095
Chloride of potassium . .	trace	—
Chloride of magnesium . .	0·106	—
Sulphate of lime . . .	1·009	0·973
„ „ magnesia . .	0·135	0·289
Carbonate of lime . . .	0·150	—
Sulphate of soda . . .	—	96·217
Sesquioxide of iron . . .	—	0·230
Sulphuric acid	—	0·885
Water	5·460	—
Sand	—	0·310
	100·021	99·999

Leblanc directed Glauber's salt, limestone, and coal, to be used in the proportions of 100 : 100 : 50; at present, however, the propor-

(1) Proceedings of the Phil. Soc. of Glasgow; Phil. Mag. [3] XXXIV, 15; Dingl. Pol. J. CXI, 343.

(2) Ann. Ch. Pharm. LXI, 129; LXIII, 104; LXVII, 78; Dingl. Pol. J. CIV, 45; CXI, 334; J. Pharm. [3] XII, 129.

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tions 100 : 103 : 62, are generally employed, as answering better. We pass over the detailed description of the balling process, and remark only that in practice the fusion is considered as complete, and the mass fit for being withdrawn from the furnace, at a period when there is still a lively disengagement of gas (called candles), and not when the latter has ceased altogether. Brown and Unger found the product of fusion to contain :

	English crude soda.	Crude soda from Ringkuhl.
	Brown.	Unger.
Sodium	18·345	18·53
Calcium	21·670	25·88
Magnesium	0·214	0·40
Iron	3·129	1·54
Alumina	1·038 (1)	trace
Sulphur	12·536	11·85
Chlorine	1·131	1·55
Sulphuric acid	0·643	1·13
Carbonic acid	14·520	15·30
Silicic acid	3·394	4·08
Water	0·700	4·99
Sand	4·285	2·02
Carbon	7·998	1·59
Ultramarine ?	0·295	—
Oxygen and loss	9·723	11·14
	100·000	100·00
Soluble portion	40·43	not determined.
Insoluble portion	59·56	

According to Unger, the water exists partly as hygroscopic moisture (2·10 per cent), and partly in chemical combination (2·89 per cent) ; no other sulphur-acid, but SO_3, could be detected, nor any poly-sulphide.—On exhausting the crude soda, a green solution is obtained, which, as is well known, is decolourized at the boiling temperature, with the separation of green flakes. Brown finds these flakes to consist of silicic acid, alumina, and a little lime, and concludes, rather hastily, that they are (decomposed) ultramarine, upon the sole ground that this compound has been now and then observed in the soda-furnaces. It is much more probable that this green colour arises from sulphide of iron, and that Brown has overlooked the iron in those flakes.

The direct results of analysis have been arranged by Brown and Unger as shown in the following table, into which we have intro-

(1) The original gives, erroneously calculated, 0·846.

duced, for the sake of comparison, an analysis, by Richardson, of crude soda from Newcastle. Soda-manufacture.

	Brown.		Unger.	Richardson.
Carbonate of soda	35·64		23·57	9·89
Hydrate of soda	0·61		11·12	25·64
Sulphate of soda	1·16		1·99	3·64
Chloride of sodium	1·91		2·54	0·60
Soda-alumina	2·35		—	—
Sulphide of sodium	1·13		—	—
Oxysulphide of calcium (3 CaS, CaO)	29·17		34·76	35·57
Caustic lime	6·30	Carbonate of lime	12·90	15·67
Sulphide of iron	4·92		2·45	1·22
Silicate of magnesia	3·74		4·74	0·88
Water	0·70		2·10	2·17
Ultramarine (?)	0·29		—	—
Carbon	8·00		1·59	4·28
Sand	4·28		2·02	0·44
	100·20		99·78	100·00

That this arrangement is more the result of speculative conjecture, than of inductive proof, is at once evident from the great difference exhibited in the above columns, when compared with the remarkable coincidence which we observe in the direct results of the analyses. The principal difference exists in a most important point, namely in the distribution of the soda. Unger assumes the surplus of lime to be in the state of carbonate, and an equivalent amount of soda to exist as hydrate. This assumption, which is of itself improbable, cannot be considered as supported by the large amount of hydrate of soda found by Schwarzenberg in the soda of Kassel, to which Unger refers, as this may be a product of the process of exhaustion. If, on the other hand, Unger shows, by a direct experiment with crucible and wind-furnace, that on subjecting to a red-heat a mixture of 3 equivalents of carbonate of lime, with 1 equivalent of Glauber's salt, and an excess of carbon, a portion of the lime remains as carbonate, this can scarcely be alleged as a proof in support of his view; for, in the open fire of the soda-furnaces, the circumstances are much more favourable for the separation of the carbonic acid from the lime. Brown, by digesting the crude soda with alcohol, by which only a very small amount of alkali was dissolved, has furnished a proof of his view, according to which the excess of lime exists as caustic lime, there being only very minute quantities of soda present in the form of hydrate.—Dumas had suggested the composition 2 CaS, CaO for the combination of lime with sulphide of calcium present in crude soda, the formation of

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which is so important for the after-process of solution. Unger has deduced, both from the result of his analysis, and from analogy with the 3 BaS, BaO, described by H. Rose, the composition 3 CaS, CaO, which has also been adopted by Brown.

The refuse left after the exhaustion of the crude soda, which contains the whole amount of sulphur in the Glauber's salt, has been analysed by both chemists, according to the same method as the crude soda; Brown examined a sample from a manufactory, and Unger, one prepared by himself from the crude soda of Cassel.

Found in Analysis.			Calculated in relation to the crude soda.		
	Brown.	Unger.		Brown.	Unger.
Sodium	?	1·06	Carbonate of lime	24·22	19·56
Calcium	32·19	39·11	3 CaS, CaO	20·36	32·80
Magnesium	0·43	0·59	Silicate of magnesia	5·99	6·91
Iron	3·96	2·56	Sesquioxide of iron	5·71	3·70
Sulphur	13·18	18·90	Sand	5·75	3·09
Sulphuric acid	2·50	—	Charcoal	12·71	2·60
Carbonic acid	11·19	8·55			
Combined water	2·10	2·56	Insoluble portion	74·74	
Hygroscopic water		3·45			
Silica	5·28	5·94	Sulphate of lime	4·28	3·69
Sand	5·75	3·09	Hyposulphite of lime	trace	4·12
Charcoal	12·08	2·60	Bisulphide of calcium	3·58	4·67
Oxygen and loss	11·34	11·59	Sulphide of calcium	8·53	3·25
			Hydrate of lime	5·58	10·69
			Carbonate of soda	1·31	—
			Sulphide of sodium	—	1·78
			Water	2·10	3·45
			Soluble portion	25·38	
				100·12	100·31

Brown found in the soda-residue 26·26 per cent of soluble, and 73·74 of insoluble matter; the latter contained 10·66 of carbonic acid, and 21·89 of calcium. It is remarkable that he makes no mention of a sodium-determination, and yet enumerates carbonate of soda in the arrangement of the results; he has, likewise, not stated specially, whether the residue investigated by him was quite fresh or not, which is of great importance, as it undergoes rapid oxidation when exposed to the air. According to Brown's approximate determination, the sulphur in the bisulphide of calcium amounts to 2·2 per cent, whilst that present in the form of hyposulphurous acid is scarcely estimable. Unger found in the former 4·68, in the latter 0·016 per cent.

Theory of the conversion of Glaubers' salt into soda.

Theory of the Conversion of Glauber's Salt into Soda.—The analyses of crude soda and of the soda-residues, the composition of which is subject to great variations, by no means afford a sufficient foundation, whereupon to construct a theory of the soda-process, as Unger has ventured to do. We are the more justified in leaving this theory unnoticed, as Unger, returning to the path of experimental inquiry, soon abandoned it himself. In two later treatises(1), the same chemist has published a series of highly valuable facts, upon which we have to report.

The first part of his investigations is devoted to the action of the coal on Glauber's salt, irrespectively of lime, and that of the Glauber's salt on lime, irrespectively of coal, at different degrees of ignition. Experiment showed:

1. That carbonic acid is not reduced, by carbon, to carbonic oxide, at the fusing-point of silver.

2. That when Glauber's salt is heated with carbon to a temperature lying between the fusing-points of 14½ carats silver, and of pure silver, a considerable quantity of carbonic acid, and only traces of carbonic oxide, are formed.

In a mixture of 26·67 parts by weight of sugar-charcoal (containing 24·27 of carbon), and 73·33 of Glauber's salt, there remained unattacked, after exposure to a red-heat (at which, as proved, no sulphide of sodium is volatilized), 11·35 parts by weight of charcoal; 12·92 parts by weight of carbon had, therefore, been oxidized by the oxygen of the Glauber's salt. According to calculation, this oxygen requires 12·39 parts of carbon for conversion into carbonic acid.

3. That by heating to redness sulphide of sodium and Glauber's salt, sulphuric acid is decomposed: for, in a mixture of charcoal with from 12 to 50 times its weight of Glauber's salt, much more of the latter is decomposed than corresponds to the amount of carbon oxidized.

4. That Glauber's salt, and carbonate of lime, interchange their acids, at the temperature at which the former is reduced by charcoal. This interchange, however, gives rise to a series of complicated phenomena; for, the constant loss, by ignition, which a mixture of Glauber's salt and carbonate of lime sustained (both chemically pure, and employed in the proportions of 1 : 3, of 2 : 3, and of 1 : 1 equivalents), invariably exceeded, by several units per cent, the loss of carbonic acid experienced by the excess of lime, *i.e.* of the carbonate of lime which had not interchanged its acid. From this observation, as well as from the analysis of the residue left after

(1) Ann. Ch. Pharm. LXIII, 240; LXVII, 78.

Theory of the conversion of Glaubers' salt into soda.

ignition, Unger concludes that 3 equivalents of Glauber's salt act on 1 equivalent of carbonate of lime, and that, besides carbonic acid, some oxygen is always disengaged, the latter evidently from the sulphate of lime. The residuary substance contains Ca SO; this residue Unger assumes to have the composition 3 CaS + CaO, SO_3, and to be the substance which is subsequently converted into the basic sulphide of calcium (3 CaS + CaO). It is not well ascertained by what the loss of oxygen of the gypsum is occasioned, and in what way the basic sulphide of calcium of the soda-residue arises from 3 CaS + CaO, SO_3.

The second part treats of the comportment of the three substances used in the manufacture of soda, when simultaneously acting upon each other under various circumstances.

1. Influence of temperature. An intimate mixture of 100 parts of Glauber's salt (anhydrous), 100 of carbonate of lime, and 55 of pulverized beech-charcoal was exposed to six different degrees of heat. The mass did not fuse at any of the temperatures; in each experiment the soluble salts were separated, and analysed.

Constituents of the soluble portion.	First degree of heat.	Second degree of heat.	Fusing-point of silver.	Fourth degree of heat.	Fifth degree of heat.	Temperature at which copper becomes soft.
Carbonate of soda .	10·8	15·4	29·0	26·0	19·0	14·4
Sulphide of sodium .	0·3	0·6	0·9	6·9	11·8	15·8
Hyposulphite of soda	0·0	0·0	0·4	0·6	0·9	1·6
Sulphate of soda . .	26·5	23·2	10·3	3·5	3·2	1·6

This table shows, that the formation of carbonate of soda increases up to a certain point with the rise of temperature, that it attains a maximum at the temperature of fusing silver, and diminishes at higher temperatures. No one of the six products can be properly called crude soda, although the three first approach it in composition, after subtraction of the large amount of undecomposed Glauber's salt. Hence, in addition to the correct composition of the mixture, and the adjustment of temperature, a third condition is requisite for the formation of crude soda, this is—

2. The influence of aqueous vapour on the red-hot mass. If the above products of ignition be exposed to a temperature, lying between the fusing-points of an alloy of 1 silver, and 9 tin, and of an alloy of equal parts of these metals, and a current of aqueous vapour be passed over them, they are converted into the true crude soda. Some experiments made with sulphide of calcium, and with a mixture of gypsum and charcoal (which decomposes aqueous vapour),

Theory of the conversion of Glaubers' salt into soda.

showed, that by the action of the vapour at a red-heat, a portion of the sulphide of calcium gives up its sulphur to the hydrogen, taking oxygen in its place (4 CaS + HO = 3 CaS, CaO + HS). The efficacy of the aqueous vapour is owing, therefore, principally to the formation of oxysulphide of calcium—that all important compound for the manufacture of soda; in the presence of carbonic acid CaO, CO_2, is likewise formed.

We conclude with the hope, that Unger may soon have the opportunity afforded him of putting to the test of practice the valuable results which he has gained by scientific experiments conducted in the laboratory, and of comparing them with those of operations on a large scale.

Soda.—The commercial products obtained from crude soda have been farther examined by Brown (loc. cit. II. p. 293), in the form in which they are generally obtained in this country. The results are given in the table below.

The fused mass (crude soda) is exhausted by warm water, according to the method of successive saturation; No. I. and II. are the salts obtained by evaporation and desiccation of this ley at 100°; the saline mass is then calcined (carbonated) in the carbonating-furnace (III. and IV.) to "*soda-ash.*"—In the so-called *carbonate of soda*-process, it is customary to evaporate nearly to dryness, and to allow the mother-liquor (containing the NaS and HO, NaO) to drain off from the crystals which are deposited during the concentration; the residuary salt, dried (V. and VI.), is finished off in the *carbonating-furnace* (VII. and VIII.) A better kind is prepared by repeated solution, evaporation, and calcination of the former (IX. and X.) This purer kind serves, moreover, for the preparation of crystallized carbonate of soda (XI. and XII.) The purest product, finally, which is sometimes employed in glass-works (XIII. and XIV.), is obtained by the calcination of crystallized soda.

	I. and II.		III. and IV.		V. and VI.		VII. and VIII.	
Carbonate of soda . . .	68·91	65·51	71·61	70·46	79·64	80·92	84·00	83·76
Hydrate of soda	14·43	16·07	11·23	13·13	2·71	3·92	1·06	0·73
Sulphate of soda . . .	7·02	7·81	10·20	9·15	8·64	7·43	8·76	9·49
Sulphite of soda . . .	2·23	2·13	1·11	1·14	1·24	1·11	trace	0·38
Hyposulphite of soda . .	trace	trace	—	—	trace	trace	—	—
Sulphide of sodium . .	1·31	1·54	—	—	trace	0·23	—	—
Chloride of sodium . . .	3·97	3·86	3·05	4·28	4·13	3·14	3·22	2·29
Soda-alumina	1·02	1·23	0·92	0·73	1·17	1·01	1·01	0·62
Silicate of soda	1·03	0·80	1·04	0·99	1·23	1·32	0·98	0·78
Insoluble portion . . .	0·81	0·97	—	—	0·97	0·77	0·71	0·84
Sand	—	—	0·31	0·46	—	—	—	—

Soda.

	IX. and X.		XI. and XII.		XIII. and XIV.	
Carbonate of soda . . .	84·31	84·72	36·47	36·93	98·12	97·98
Hydrate of soda . . .	trace	0·28	0·94	0·54	1·08	1·12
Sulphate of soda . . .	10·26	9·76	—	—	—	—
Sulphite of soda . . .	trace	—	—	—	—	—
Chloride of sodium . .	3·48	3·14	0·42	0·31	0·74	0·56
Soda-alumina	0·63	0·71	—	—	—	—
Silicate of soda	0·41	0·32	—	—	—	—
Water	—	—	62·15	62·21	—	—
Insoluble portion . . .	0·25	0·50	—	—	—	—

Beringer(1)—relying upon the fact, that sulphide of sodium is not decomposed by carbonic acid except in the presence of aqueous vapour, at a red-heat, and that this rather slow process is accelerated by admitting free carbonic acid—has conceived the idea of manufacturing, in this manner, soda without limestone, from the reduced Glauber's salt. He acknowledges, however, that this idea is not practical in its application to the usual soda-process—a view with which we perfectly agree—and wishes to confine it to the working up of the mother-liquors. For this purpose, the carbonic acid from the lime-kilns of the chloride of lime manufactories is to be employed; which, however, would, in practice, be more troublesome than profitable.

New Method of Manufacturing Soda.—In the commencement of 1847, Tilghman(2) took out a patent, in England, for a process of manufacturing soda, which has attracted much attention, and would, if its practicability should be confirmed, create a great revolution in this branch of industry. The conversion of the chloride of sodium into soda is effected by his process without the use of sulphur, or of sulphuric acid,—solely by the action of aqueous vapour and alumina (prepared by igniting sulphate of alumina), at a red-heat. The alumina is placed, in pieces of $\frac{1}{4}$ of a hundred weight, into a red-hot cylinder of fire-clay, through which steam, mixed with the vapour of chloride of sodium, is passed. The latter is obtained by passing the steam into a cast-iron retort, in which chloride of sodium is maintained in a state of fusion. The products of this reaction are, on the one hand, hydrochloric acid which streams into a condenser, on the other hand, a mass containing aluminate of soda which remains in the cylinder; after exhaustion with hot water, and desiccation, the residuary alumina may be used again. The ley containing the aluminate of soda is treated with carbonic acid, and thus converted

(1) Dingl. Pol. J. CIV, 286.
(2) Repert. of Patent Inventions, Sept. 1847, 160; Dingl. Pol. J. CVI, 196.

into carbonate of soda. The action of alumina on chloride of sodium, however, is by no means energetic at a red-heat, and the employment of a white-heat would, in practice, be attended with many difficulties.

New method of manufacturing soda.

In another part of his patent, the inventor of the new soda-process opens a no less inviting prospect, by indicating a similar method for the conversion of chloride of sodium into sulphate of soda, without the aid of sulphur, or free sulphuric acid, which may then be transformed into carbonate of soda. For this purpose, an earthenware cylinder is filled with equal parts of chloride of sodium and gypsum, and the charge being heated to redness, aqueous vapour is passed over it. The hydrochloric acid formed is collected in a condenser. The soluble salts of the product are extracted with water, and the Glauber's salt separated by crystallization from the undecomposed chloride of sodium.

The inventor mixes the Glauber's salt, thus obtained, with pulverized alumina, spreads the mixture on the hearth of a reverberatory furnace, and passes a current of steam over the red-hot mass which is kept continually stirred. After the decomposition is effected, the soda is extracted with water, and the solution treated with carbonic acid, as mentioned in the foregoing case.

Whether these methods are calculated to replace the prevailing process of Leblanc, and if so, which of the two possesses the greatest practical advantages, must be decided by farther experience; the results, up to the present time, have not been made public. In an experiment on the small scale, upon the decomposition of chloride of sodium, by gypsum, and aqueous vapour, an abundant disengagement of hydrochloric acid, as well as the reactions of Glauber's salt in the soluble portion of the residue, were observed, if a glass combustion-tube was employed, but not when the process was conducted in a gun-barrel. Hence, the silica in the retorts used for the decomposition would appear to play but too important a part in Tilghman's patented process.

Salt. Salt-works.—In his memoir, "Untersuchung der königl. würtembergeschen Salinen," Fehling has examined, not only the salt-brines (*vide* his analyses, II. p. 257), but also various secondary products of the salt-works, and the salt destined for commerce. The eighteen kinds of commercial common- and rock-salt contain, in addition to chloride of sodium, chloride of calcium, sulphate of soda, sulphate of lime, carbonate of lime, carbonate of magnesia, alumina,

Salt. Salt-works.

and moisture. The rock-salt of Wilhelmsglück contains from 98·36 to 99·97 per cent of chloride of sodium; the different varieties of common-salt contain between 92·19 per cent (middling salt from Friedrichshall), and 98·9 per cent (schwäbisch Hall) of chloride of sodium. Sulphate of lime is the predominant impurity. Other chlorides, besides chloride of calcium, are not present as impurities, and this latter is contained only in six kinds.

All the mother-leys (the spec. grav. of which varies between 1·2028 and 1·2081) contain chloride of sodium, bromide of sodium, chloride of calcium, sulphate of lime, and chloride of magnesium; only five contain chloride of potassium, only two sulphate of soda, and one sulphate of magnesia. By farther evaporation of these, the so-called "concentrated mother-leys" are obtained, which are better adapted for medicinal purposes, and distant carriage. Their spec. grav. is between 1·2143 and 1·2555; they contain estimable quantities of chloride of potassium which was not detectable in the original mother-leys. The more soluble salts are present in considerably larger, and the chloride of sodium in correspondingly smaller quantities. This is particularly exhibited in the amount of bromide of sodium: in the first mother-ley of Friedrichshall, this salt is contained to the extent only of 2 grains, in the second of 14·8 grains, but in the third, there is as much as 57·5 grains to the pound. Iodine was not detectable in any one of the liquors.

Of the incrustations deposited in the pans, five were examined, and found to contain chloride of sodium, chloride of calcium, chloride of magnesium, sulphate of soda (only in that from schwäbisch Hall), and sulphate of lime, as principal constituents, besides the carbonates of lime and magnesia (only in that from schwäbisch Hall), sesquioxide of iron, alumina, clay, silica, and water.

Manufacture of Chromates.—Jacquelain(1) has published a process for the conversion of chrome-ore (chromoferrite) into bichromate of lime, from which the bichromate of potassa may be prepared by double decomposition. This method is more convenient and cheaper than the direct manufacture of the potassa-salt from the ore.

The ores, ground to an exceedingly fine powder, and sifted, are mixed in revolving casks with chalk; the mixture thus obtained is exposed, in layers of from 1½ to 2 inches thickness, upon the hearth of a reverberatory furnace, for from 9 to 10 hours, to a bright red-

(1) Moniteur Industriel, 1847, No. 1182; Dingl. Pol. J. CVI, 405; CVII, 134; J. Pr. Chem. XLIII, 202; comp. the other references, Vol. I. p. 318.

heat, and turned at least every hour. After this treatment the mass is soluble in hydrochloric acid, with the exception of the sandy portions; it has a yellowish-green appearance, and consists now principally of neutral chromate of lime.—The resulting mass is rubbed down between millstones, then suspended in hot water, and sulphuric acid added, until the reaction is slightly acid, the mixture being kept continually stirred. The lime-salt is thus converted into the bichromate; it still contains sulphate of protoxide of iron which may be precipitated in the same vessel, by means of milk of lime, whereby the chrome-salt is not altered. After the liquid has become clear by standing, it is removed from the sediment, and contains now only bichromate of lime, together with some gypsum; it may be used at once for the preparation of bichromate of lead, potassa, &c. Manufacture of chromates.

Tilghman(1) proposes to expose the finely powdered chrome-ore, mixed with 2 parts of sulphate of potassa, and 2 parts of lime, to a red-heat, for from 18 to 20 hours, in the powerfully oxidizing fire of a reverberatory furnace, through which, simultaneously, a current of aqueous vapour is conducted.

Another proposal of the same chemist, worthy of attention, is to ignite the chrome-ore with powdered felspar and lime.

Manufacture of Ferrocyanide of Potassium.—The invention of Possoz and Boissière(2), of preparing ferrocyanide of potassium with the aid of atmospheric nitrogen, which has of late created considerable sensation, consists in exposing, for 10 hours, to an intense white-heat, powdered charcoal, saturated with 30 per cent of potassa, in vertical, wide, earthenware cylinders, through which a current of air is made to pass. The ignited charcoal is mixed with powdered iron-spar, and exhausted.

Hardening of Plaster of Paris.—According to Keating(3), gypsum may be readily hardened by means of borax, in the same manner as with alum. For this purpose, he soaks the ignited mass of gypsum completely with a solution of 1 part by weight of borax, in 9 parts by weight of water, afterwards strongly ignites it for a period of 6 hours, and then reduces it to powder. Still better results are obtained, by adding to the above solution 1 part by weight of bitartrate of potassa, and the double amount of water.

(1) Repert. of Patent Inventions, 1847, 155, 160; Dingl. Pol. J. CVI, 195, 201.

(2) Compt. Rend. XXVI, 203; Dingl. Pol. J. CVII, 444. For the description and drawings of the apparatus, *vide* Lond. J. of Arts 1845, 380; Dingl. Pol. J. XCV, 293; also Repert. of Patent Inventions 1847, 280; Dingl. Pol. J. CIV, 446.

(3) Repert. of Patent Inventions, 1846, 184; Dingl. Pol. J. CIV, 158; J. Pr. Chem. XL, 191; Bull. Soc. d'Enc. 1847, 93.

Addition of slags to hydraulic cements.

Addition of Slags to Hydraulic Cements.—Elsner(1) has induced two of his pupils to investigate a slag from an iron-furnace at Gleiwitz, which is known to form with lime an hydraulic cement. The slag had a greenish colour, which disappeared, with evolution of hydrosulphuric acid, on pouring hot acetic acid over the fine powder, the acid dissolving at the same time a portion of iron which had probably been present in the form of sulphide of iron. When treated with hydrochloric acid, the slag formed a thick jelly.

	Jacobi. 1.	Grashof. 2.
Silicic acid	40·12	40·44
Alumina	15·37	15·38
Lime	36·02	33·10
Protoxide of manganese	5·80	4·40
„ „ iron	1·25	1·63
Potassa	2·25	2·07
Sulphur	0·70	0·76
	101·51	97·78

From these numbers Elsner has calculated the formula:

$$2\,(3\,CaO, SiO_3 + Al_2O_3, SiO_3) + 3\,CaO, 2\,SiO_3.$$

Manufacture of White-lead.—Gannal(2) has published a method of manufacturing white-lead; we give here only the main features of his process, since it is merely a modification of Wood's plan(3), and of that which was at an earlier period proposed by Prechtl(4).—A cylinder, 2^m in length, and from 0·3 to $0·4^m$ in diameter, constructed of sheet-lead, of from 5 to 8^{mm} in thickness, is encased with a wrought iron framing, in such a manner that it may be revolved upon its axis 50 times in a minute; granulated lead and water are introduced through a wide bung-hole; through a smaller opening, opposite to the handle, passes into the drum a leather hose, conveying a stream of carbonic acid which is prepared by the combustion of charcoal, and forced in by means of a bellows. The process is accelerated by adding to the water a small quantity of nitric acid, or of nitrate of lead. The product is subsequently washed from the finely divided lead which remains unaltered.

Tourmentin(5) has taken out a patent for preparing white-lead by means of basic chloride of lead, which is obtained from common salt and litharge. This compound is mixed with so much water,

(1) Verh. Gew. Bef. Pr. 1847, 3. Lieferung; Dingl. Pol. J. CVI, 321.
(2) Journ. Franklin Inst. Jul. 1847; Dingl. Pol. J. CVI, 273.
(3) Dingl. Pol. J. LIV, 127.
(4) Prechtl, Techn. Encycl. II, 466.
(5) Lond. J. of Arts, 1848, 269; Dingl. Pol. J. CIX, 218.

that a stream of carbonic acid, prepared in the manner above-mentioned, can be passed through it without difficulty. (For a drawing of the apparatus, compare loc. cit. p. 304). When the liquid is saturated with carbonic acid, neutral chloride of lead is formed, and white-lead. It is now transferred to a leaden vessel, and boiled with a sufficient quantity of powdered chalk which is free from iron, until the filtrate is no longer blackened on addition of sulphide of ammonium. The white-lead which is thus formed, is separated from the lime-salt, and at the same time from other impurities, by washing. Manufacture of white-lead.

Stannate of Soda.—R. Brown has endeavoured to apply the observation (comp. Vol. I. p. 334), that stannate of soda is formed by boiling metallic tin with a solution of soda, to the technical preparation of this salt on a large scale, without, however, obtaining satisfactory results.

Substitute for Green Arsenic Colours. Titanium-green.—As a substitute for the green arsenic-pigments employed in painting, and in the printing of paper-hangings, Elsner(1) has proposed the innoxious titanium-green (ferrocyanide of titanium), which is prepared by precipitating titanic acid with ferrocyanide of potassium, in the following manner. Washed rutile, or iserine, is decomposed with 12 parts by weight of bisulphate of potassa, in a Hessian-crucible; the fused mass is pulverized, digested at 50° with hydrochloric acid which is diluted with twice its weight of water, and filtered. The filtrate is evaporated until a drop solidifies upon a cold plate; at this stage it forms, in the evaporating-dish, a paste which is well drained upon a filter, and then continuously boiled in a porcelain basin, with addition of sal-ammoniac, in order to prevent the formation of a basic iron-salt. This process, and subsequent washing and filtering, renders the difficultly soluble titanic acid almost white.—Carbonate of lime which iserine usually contains, may previously be readily removed, by means of hydrochloric acid.—For the purpose of preparing ferrocyanide of titanium, the pasty mass obtained in the above manner is treated with a concentrated solution of sal-ammoniac, well agitated and filtered. The titanic acid which remains upon the filter is now digested, at from 50° to 60°, with dilute hydrochloric acid, until, if possible, complete solution ensues, and the acid liquid, after addition of solution of ferrocyanide of potassium, rapidly heated to ebullition. The beautifully dark-green precipitate is washed with water acidulated with hydrochloric acid,

(1) Verh. Gew. Bef. Pr. 1846, 5. Lieferung; Dingl. Pol, J. CV, 130.

Borate of protoxide of copper.

and dried with great care, since it decomposes at temperatures above 100°. The colour, however, is very inferior to Schweinfurt-green, &c.

From the residuary liquid obtained in the preparation of titanic acid, a farther quantity of acid may be obtained by evaporation.

Borate of Protoxide of Copper.—Bolley(1), of Aarau, has recommended for the same purpose the borate of protoxide of copper. The precipitate obtained from 16 parts of sulphate of copper, and 24 parts of borax, is washed with cold water, it being decomposed by hot water, and dried at first at the ordinary temperature, and towards the end of the operation, in a warm place. The horn-like mass is then deprived of its water by ignition in a Hessian-crucible, fusion being carefully avoided. In this manner it acquires a pretty yellowish-green tint which, upon longer ignition, assumes a dark-green shade. The powdered mass is levigated before use.

According to the "Berliner Gewerbe-, Industrie- und Handelsblatt"(2), the colour of this borate of protoxide of copper is a light bluish-green, and not adapted as a substitute for the green arsenic-pigment.—Both the titanium-green, and the borate of copper, according to Beringer(3), are too expensive. He prefers to employ the green prepared by mixing chrome-yellow, and Prussian blue, instead of that which is obtained from Prussian blue and yellow vegetal colours, as formerly proposed by Elsner.

Manufacture of Glass and Pottery. Ancient Stained Glass.—J. Müller(4) has investigated red, blue, and yellow glass, selected from the stained windows of the "Wiesenkirche," at *Soest*. These windows, of the purest German style, are now in course of restoration.

The *red* contained silicic acid, alkalies, lime, magnesia, alumina, protoxide of iron and of copper (suboxide ?); the *blue*, silicic acid, lime, alumina, protoxide of cobalt, sesquioxide of iron, binoxide of tin; the *yellow*, silicic acid, alumina, and sesquioxide of iron. Other constituents have not been searched for.

Artificial Aventurine.—C. Kersten(5) has analysed the artificial aventurine from the glass-manufactory of Bigaglia in Venice. The

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(1) Schweiz. Gew. Blatt, 1847, 28; Dingl. Pol. J. CV, 158.
(2) Dingl. Pol. J. CVI, 157.
(3) Dingl. Pol. J. CVIII, 144.
(4) Jahrb. Pr. Pharm. XVII, 265.
(5) J. Pr. Chem. XLII, 138.

specimen was sent to him by Wolf, director of the glass-house at Adorf, near Winterberg, in Bohemia. It yielded: Artificial aventurine.

Silicic acid . .	67·3	83·0	Brought forward .	83·0	These numbers agree, in a remarkable manner, with the results formerly obtained by Péligot.
Lime	9·0				
Protoxide of iron.	3·4		Metallic copper .	4·0	
Binoxide of tin .	2·3		Potassa	5·3	
Protoxide of lead.	1·0		Soda	7·0	
				99·3	

Hæmatinone.—Under the name of *hæmatinone*, a kind of glass was in use with the ancients, for the purpose of making ornamental vessels, mosaics, &c. It is described by Pliny, among others, and has been found pretty abundantly in the excavations at Pompeii. This glass is distinguished by its beautiful red colour, which lies between those of minium and of cinnabar. It is opaque, harder than ordinary glass, susceptible of a fine polish, of conchoidal fracture, and of a spec. grav. = 3·5. By fusion it loses its red colour, which cannot, by any method, be restored. It then forms a greenish-black mass which, by reducing agents, at the most assumes but a dull brownish-red colour. Hæmatinone contains no tin, or any other colouring-matter, besides suboxide of copper.—All attempts of the moderns to imitate the antique hæmatinone have hitherto failed, for even the Italian so-called porporino entirely differs from it in every respect. M. Pettenkofer(1), by analysis of hæmatinone, and synthetic experiments based thereon, has at last succeeded in devising a method of producing this material in large quantities, so that, with the requisite precautions, it may be cast into plates of any size, and worked into articles of every description.—This invention of Pettenkofer, which has not yet been published, promises to the author not only the thanks of the arts, but also of science, inasmuch as hæmatinone is closely allied in its properties and nature to the red surface-glass, and to artificial aventurine, so that we may expect from this discovery some farther elucidation of the still enigmatical manufacture of these remarkable products.

Enamel for joining Porcelain.—For the purpose of uniting broken porcelain, A. Wächter(2) recommends a glass-flux, consisting of 3 parts by weight of minium, 2 parts of finely levigated white sand, and 3 parts of crystallized boracic acid which, in colour and expan-

(1) Dingl. Pol. J. CVII, 78, where Pettenkofer adduces the above properties.
(2) Dingl. Pol. J. CX, 416.

Enamel for joining porcelain.

sion, is stated to agree perfectly with porcelain. The ingredients are fused together, and after cooling, finely levigated. For the above-mentioned purpose, the flux is laid on with tragacanth-water, and then fired in the muffle at a very gentle heat; it should not be allowed to become entirely, but only partially fused. The requisite temperature is so low, that articles, painted with enamel-colours, or gilt, may be united without suffering the least injury.—This glass-flux belongs to the white-enamels—*i. e.* it has the property, when rapidly cooled, of forming a colourless, transparent glass which, when subsequently heated to near its fusing-point, becomes white and opaque, as is the case with all enamels. The opacity thus occasioned is so delicate, that even when strongly magnified under the microscope, the individual particles cannot be detected.

Bohemian Glass.—Thomas Rowney(1) has analysed the kind of Bohemian glass which, on account of its difficult fusibility, is employed for combustion-tubes. He selected for this purpose the best tubes from the stock of the Royal College of Chemistry, the primary origin of which, he was, however, unacquainted with. The specimen examined was decomposed by means of carbonate of soda, and gave, as the mean of two determinations :

Silicic acid . . .	73·13	Foregoing constituents .	84·25	
Lime	10·43			
Alumina	0·30	Protoxide of manganese.	0·46	The oxygen of the
Sesquioxide of iron	0·13	Soda	3·07	bases : to that of the
Magnesia . . .	0·26	Potassa	11·49	acids = 1 : 6.
	84·25		99·27	

Formation of Crystals in Sheet-Glass.—H. Reinsch(2) has communicated some interesting observations upon the formation of crystals in sheet-glass. The author had an opportunity of investigating some defective specimens, obtained from the glass-house of Vopelius, situated in the Sulzbach Valley, in the Palatinate. These defects presented to the unaided eye white elevated points which, when magnified 500 times, were resolved into groups of small crystals, of from $\frac{1}{250}$ to $\frac{1}{500}$ inch in diameter. The greater number of these crystals show the figure of a regular six-branched star, whose outlines appear corroded and indented, so that, according to the drawings of the author, they exhibit the appearance of the

(1) Phil. Mag. [3] XXX, 421 ; J. Pr. Chem. XLI, 189.
(2) Jahrb. Pr. Pharm. XV, 146.

ice-flowers deposited on the windows during winter, of snow, or of foliated ornaments. Others consist of needles, terminated by acute edges. The minute size of these crystals, and the impossibility of separating them from the glass, prevented an accurate examination of their chemical nature; nor could their form be determined by exact crystallographical measurement. However, their regular six-sided appearance sufficed for the author to consider them as quartz. This conjecture he supports by a very bold and far-fetched explanation which we pass over as perfectly untenable. Groups of crystals are found, not only upon both surfaces, but also in the mass of the glass.—By comparing the appearance of the glass cylinders with that of the glass sheets, the author might have probably been able to ascertain, whether the formation of the crystals did not arise from ordinary devitrification, a process which is highly promoted by the stretching of the sheets.

Formation of crystals in sheet-glass.

Raw Materials, and Products of British Pottery.—R. A. Couper(1) has published a comprehensive investigation regarding the raw materials and wares of the British potteries.

I. Clays.—1. *Clay from Cornwall,* the so-called *china-clay,* which is a kind of kaoline; this is obtained as a fine sediment, by washing the decomposed granite, and exposing the felspar thus obtained to the air for a period of from four to five months. Dried at 100°.—2. *Clay from the upper stratum of the clay-fields* (*sandy-clay,* termed also *stiff-clay,* or *ball*). It is employed, in consequence of the large amount of silica it contains, as the basis of the wares which are glazed with common salt. Spec. grav. 2·558.—3. *Clay from the second stratum of the clay-field* (*pipe-clay*), employed in the manufacture of tobacco-pipes.—4. *Blue clay,* of a greyish colour, becoming white when burned.—5. *Red, or brown clay,* belonging to an upper stratum, occurs abundantly near Glasgow; it is rich in iron, and assumes a dark-brown colour on burning; it is employed for ordinary wares, flower-pots, bricks, &c.—6. *Yellow clay,* occurs in several localities of England, and assumes, when burnt, a yellow colour in consequence of the iron it contains. A similar clay is made by mixing No. 2. with No. 5. It is employed in the manufacture of the so-called cane- and Rockingham-wares.—7. *Fire-clay,* which is also, although incorrectly, termed *marl.* Employed in making capsules,

(1) Phil. Mag. [3] XXXI, 435; Dingl. Pol. J. CVII, 196; Bull. Soc. d'Enc. 1848, 196.

Earthen-wares.

saggars, crucibles, fire-bricks, &c. It burns into a porous mass, in consequence of the coarse nature of its constituents.

Besides the above, flint and half-decomposed granite (*Cornish-stone*) are also employed, both being calcined, levigated, and washed.

II. Earthen-Wares.—1. *Porcelain.* This is manufactured in England from flint (*Cornish-stone*), china-clay, and bone-earth; the latter ingredient does not form a constituent of the continental porcelain. The specimen No. 1, and the specimens No. 2. and No. 3, were obtained from different manufactories. For the sake of comparison the following kinds were analysed: No. 4, a specimen of Berlin porcelain, of spec. grav. 2·419; No. 5, a fine Chinese variety, of spec. grav. 2·314; and No. 6, an inferior Chinese porcelain, of spec. grav. 2·314. No. 7, ordinary white earthenware, which is a kind of delf-ware, manufactured from flint, granite, china-clay, and blue clay. The specimen was procured from Glasgow; it had a spec. grav. = 1·36. This ware is frequently coloured through the entire mass, the shade being blue, sage-coloured, &c.

III. Glaze for No. 2.—In the first place a *frett* is prepared of borax, china-clay, flint, granite, and Paris white. This frett, which is a perfect glass, is thrown into water, mixed with an additional quantity of granite, flint, and white-lead, and finely levigated. No. 8. is the fret, No. 9. the glaze.

IV. Colours.—No. 10, cobalt-blue, which is employed in the process of painting.

The other colours have not been investigated; for some farther interesting statements regarding these substances we refer to the treatise itself.

I. Varieties of Clay.

Order of number .	1.	2.	3.	4.	5.	6.	7.
Analysis by . .	Couper.	Couper.	John Brown	J. Higginbotham.	Couper.	Couper.	John Brown.
Silicic acid . . .	46·31	66·68	53·66	46·38	49·44	58·07	66·16
Alumina	39·91	26·08	32·00	38·04	34·26	27·38	22·54
Magnesia . . .	0·44	trace	trace	trace	1·94	trace	trace
Lime	0·43	0·84	0·40	1·20	1·48	0·50	1·42
Protoxide of iron .	0·27	1·26	1·35	1·04	7·74	3·30	5·31
Alkali	12·67	—	—	—	—	—	—
Water		5·14	12·08	13·57	5·14	10·30	3·14
	100·03	100·00	99·49	100·23	100·00	99·55	98·57

II. Clay-Wares.

Order of number .	1.	2.	3.	4.	5.	6.	7.
Analysis by . . .	Couper.	Couper.	Crichton.	Couper.			
Silicic acid . . .	39.88	40·40	39·68	72·96	71·04	68·96	68·55
Alumina . . .	21·48	24·15	24·65	24·78	22·46	29·24	29·13†
Magnesia . . .	—	0·43	0·31	—	—	—	—
Lime	10·06	14·22	14·18	1·04	3·82	1·60	1·24
Phosphate of lime. Protoxide of iron .	26·44	15·32	15·39	—	—	—	—
Alkali	2·14*	5·28	5·79	1·22	2·68	—	—
	100·00	100·00	100·00	100·00	100·00	100·00	98·92

* This, and the four following numbers, are calculated from the loss.

† Alumina and sesquioxide of iron.

A more scientific mode of procedure would have conferred upon these analyses a higher interest, especially with regard to the clays; we cannot judge from the foregoing remarks to what extent disintegration had proceeded, how much of the silicic acid was in combination, how much in the free state, &c. Moreover, a complete geological description of the clays would have been very desirable.

	No.	Silicic acid.	Lime.	Alumina and sesquioxide of iron.	Borax.	Carbonate of lime.	Carbonate of lead.	Sesquioxide of iron.	Protox. of cobalt.	Water.
Frett for glaze	8	55·98	5·52	10·38	31·12	—	—	—	—	—
Glaze . . .	9	43·66	0·52	9·56	20·08	10·08	15·19	—	—	—
Cobalt-blue .	10	17·48	—	—	—	28·45	—	25·50	19·42	8·41

Heating Porcelain-Furnaces with Coal.—The fuel hitherto used in porcelain-furnaces has been almost exclusively wood, the most expensive of all combustibles. The employment of coal has been either unsuccessful, or at least only partly practicable; as, for instance, in the factory of Meissen, where a mixture of $\frac{3}{4}$ lignite and $\frac{1}{4}$ coal is burned. Vital Roux(1) has recently published a process, and constructed a furnace by means of which coal exclusively can be burned, without risking the usual inconvenience of colouring the ware by smoke.—The process consists in feeding the fire with a double current of air, the coal being added in small portions at

(1) Bull. Soc. d'Enc. April, 1847, 180; Ebelmen's Report, April and July, 380; Dingl. Pol. J. CVII, 207; Technolog. May, 1847, 346; Dingl. Pol. J. CIV, 634.

Vases craquelés.

short intervals; the draft is upwards. In this manner a saving of 53 per cent is effected over the former cost of the fuel. For the details as well as for the drawings we refer to the original paper.

Vases Craquelés.—The highly valued Chinese porcelain vessels, known by the appellation "*vases craquelés,*" and distinguished by a peculiar glaze permeated by numerous fissures, and presenting the appearance of a regular network, have as yet been only obtained accidentally, and cannot be formed at will. According to St. Julien(1), who has derived his information from a Chinese work on pottery "*Kin-tê-tschîn-tao-lou,*" they are produced by mixing the glaze with steatite.

Platinum Lustre.—The ordinary coating of platinum upon earthenware, which is known under the name of platinum lustre, could hitherto be imparted only to glazes containing lead, the effect being produced by employing an emulsion of solution of platinum and linseed-oil. According to Luedersdorff(2), a lustre applicable to all glass surfaces, and also to porcelain, may be obtained by dissolving bichloride of platinum which has been evaporated to dryness, decomposition being carefully avoided, in spirit of wine containing from 95 to 96 per cent of alcohol, and slowly pouring the solution into five times its quantity of oil of lavender. Protochloride of platinum is formed, which remains dissolved in consequence of the simultaneous production of acetic or hydrochloric acid. In the case of vessels covered with lead-glaze, the process of firing requires a dull-red heat, with porcelain and glasses free from lead a bright-red heat is necessary.

Silvering.—According to the discovery of A. Rousseau(3), the black tarnish of the dead silver-coatings of porcelain can be prevented by spreading an extremely thin layer of gold upon the silver previously to the firing. By this means a white alloy of gold and silver is formed which is very durable. In order, however, to insure success in the operation, many precautions are necessary.

Enamel Colours.—The mixture and preparation of enamel-colours for the purpose of painting porcelain has hitherto been involved in obscurity. The subject has received considerable light from a valuable investigation by A. Wächter(4), which is distinguished by

(1) Compt. Rend. XXIV, 1069; J. Pr. Chem. XLI, 286.

(2) Verh. Gew. Bef. Pr. 1847, 2. Lieferung, S. 67; Dingl. Pol. J. CV, 36.

(3) Bull. Soc. d'Enc. Febr. 1847, 75; Dingl. Pol. J. CIV, 204; Chem. Gaz. 1847, 395.

(4) Ann. Ch. Pharm. LXVIII, 115; LXIX, 99; Chem. Gaz. 1849, 65.

Enamel colours.

the lucid manner in which it communicates the results of practical experience, whilst great reserve was exhibited in the statements of earlier authors. He gives ample information regarding the composition, and definite directions for the preparation of the following colours: *purple, violet and rose,* these three being produced by means of gold; *yellow* from antimony and uranium; *green* from sesquioxide of chromium; *blue* from protoxide of cobalt; *black* from iridium, and likewise from cobalt and manganese; *gray* from the same materials; *red* and *brown* from sesquioxide of iron, and partly from chromium, and lastly of *white enamel* and *colour-flux.* Whilst we refer for farther details to the treatise itself, we may still remark that, according to the author, the colours fixed by firing, present under the microscope three distinct appearances; 1. that of homogeneous transparent glasses; 2. that of transparent coloured particles, dispersed within transparent and colourless media; 3. that of a kind of enamel, or of an opaque precipitate diffused in a transparent mass.

Stone-Wares.—Salvetat(1) has analysed the following varieties of stone-ware, the specimens being in each case, after pulverization, exhausted with water for the purpose of removing any accidentally adhering salt employed in glazing: 1. stone-ware from *Vauxhall,* near London, a fine whitish body well moulded, with a porous external surface, glazed with salt; 2. from *Helsingborg,* coarse grain, grayish body, badly moulded, glazed with salt; 3. from *Frechen,* dark-brown body, well moulded, with earthy glaze; 4. obtained from Ziegler of *Voisinlieu,* well moulded, whitish body, salt-glazed; 5. from *St. Amand,* ordinary body, earthy glaze; 6. from *Saveignies,* light-brown body, coarse grain, very soniferous; 7. *Chinese* stone-ware, very similar to the preceding specimen; 8. from *Japan,* similar to the preceding specimen; 9. from *Baltimore,* very fine whitish body; 10. *Wedgwood*-ware, fine yellowish body, very soniferous and well moulded.

The figures of the analyses distinctly point out two different kinds of stone-ware: such as contain from 62 to 66 per cent of silicic acid as No. 3. and the five last specimens which are either unglazed, or have merely an earthy glaze; and such as contain 75 per cent of silicic acid, as is the case with the four remaining specimens which are glazed with common salt.—By this method of glazing, the salt is invariably decomposed whenever a sufficient amount of silicic acid is present, whether it be in the free or combined state.

(1) Ann. Ch. Phys. [3] XXIII, 249; Dingl. Pol. J. CIX, 440.

Stone-wares.

	Glazed Stone-Ware.					Unglazed Stone-Ware.				
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
Silicic acid . . .	74·00	74·60	64·01	74·30	75·00	65·80	62·00	62·04	67·40	66·49
Alumina . . .	22·04	19·00	24·50	19·50	22·10	27·64	22·00	20·30	29·00	26·00
Magnesia . . .	—	trace	0·92	0·80	trace	0·64	trace	trace	—	0·15
Lime	0·60	0·62	0·56	0·50	0·25	1·12	0·50	1·08	0·60	1·04
Protoxide of iron .	2·00	4·25	8·50	3·90	1·00	4·25	14·00	15·58	2·00	6·12
Alkalies	1·06	1·30	1·42	0·50	0·84	0·24	1·00	trace	0·60	0·20
	99·70	99·77	99·91	99·50	99·19	99·89	99·50	99·00	98·60	100·00

Agricultural Chemistry. Relation of the nitrogen contained in crops to that of the manure.

Agricultural Chemistry. Relation of the Nitrogen contained in Crops to that of the Manure.—Schlossberger(1) has given a detailed critique of Hermbstädt's position, that the amount of nitrogen in the grain of the *cerealeæ* (the quantity of gluten they contain) stands in direct proportion to the nitrogen of the manure which is employed. The author was induced to this review by some discrepancies he met with in the description of Hermbstädt's experiments, according to which, pigeon's dung with 8 per cent of nitrogen yielded corn containing 12 per cent, while human excrement, or excrement of goats, with from 2 to 3 per cent of nitrogen, produced grains containing not less than 33 per cent (?) of this element. Experiments made in 1846, by John, of Hohenheim, the details of which have not yet been published, did not exhibit any constant relation of this kind; the same was likewise the case with those of Burnet, in England, to which the author farther alludes. Burnet found the proportion of gluten contained in wheat varied only between 9·4 and 10·5 per cent in the following five cases: no manuring; manuring with urine, sulphuric acid and wood-ash; with urine, sulphuric acid, and Glauber's salt; with urine, sulphuric acid, and common salt; and lastly, with urine, sulphuric acid, and nitrate of potassa.

Influence of Common Salt as Manure.—Dubreuil, Fauchet, and Girardin(2) have made experiments upon manuring corn (*blé russe*) with common salt. The salt was employed in various proportions on different parts of the field, whilst for the sake of comparison a portion of the same field was cultivated without salt. The influence of the latter was manifested in the crops by a decidedly rich and

(1) Dingl. Pol. J. CV, 451, from Riecke's Wochenblatt, 1847, No. 35.
(2) Compt. Rend. XXVI, 308.

luxuriant appearance, but in most cases accompanied also by a great inclination in them to "*lay*." By manuring with salt the produce was in general greater both in straw and in grain, especially when not more than from 3 to 4 kilogr. per acre was employed; beyond this quantity its influence was more upon the straw than on the grain. At the market-price of salt in France (40 fr. the 100 kilogr.), the increase of produce did not, however, compensate for the outlay.

Influence of common salt as manure.

Previous to the experiment, clover had been cultivated upon the field which was dressed with a half coat of manure.

Pigeon-Dung.—Egyptian pigeon-dung, imported as an article of commerce, has been analysed for the Royal Agricultural Society of England(1), with the following results:

Water	6·65
Organic substance with 3·27 per cent of nitrogen (=3·96 ammonia)	59·68
Ammonia	1·50
Alkaline salts	0·42
Phosphate of lime and magnesia	7·96
Carbonate of lime	2·37
Sand	21·42

Relation between the Production of Nitre, and the Fertility of Soil, yielding it.—F. Kuhlmann(2) has been led, by his researches respecting the transformation of ammonia into nitric acid and of nitric acid into ammonia, to some considerations upon the relation of these phenomena to the fertility of soils. He has arrived at the conclusion, that, in this case, two distinct reactions take place; the one occurring at the surface, by which the fertilizing element (carbonate of ammonia) becomes fixed in the generation of nitre which is formed under the influence of atmospheric oxygen, while the other, taking place at a certain depth, reconverts the nitric acid into ammonia under the influence of putrid fermentation.—Both, action and reaction, according to his views, must go hand in hand in order to promote the fertility of the soil. On certain tracts of land in which the second condition is wanting, the nitre accumulates and forms saltpetre-beds, as in Ceylon, India, &c. (Comp. Vol. I. p. 293 and 298).

Kuhlmann(3) has, moreover, published a continuation of his experiments upon the nature of manure. He has arrived at the general conclusion, that the nitrogenous constituents of manure are the chief agents of its efficiency, but that the saline constituents

(1) Dingl. Pol. J. CVI, 159.
(2) Ann. Ch. Phys. [3] XX, 223; J. Pr. Chem. XLI, 289.
(3) Ann. Ch. Phys. [3] XX, 265; J. Pr. Chem. XLI, 417; XLII, 63.

Mineral manures.

have likewise a share therein, which is the greater the nearer they approach (under favourable conditions) the necessary degree of solubility. Respecting the numerous and interesting details we refer to the original memoir.

Mineral Manures.—Persoz(1) obtained a striking and remarkably favourable result in planting hortensias in ordinary mould, manured with a mixture of 3 kilogr. of bone-black, 1·5 kilogr. of nitric acid, and 0·5 kilogr. of phosphate of potassa. The specimens far surpassed in the development both of leaves and flowers others which, for the sake of comparison, were planted under similar circumstances in mould without manure. The same phenomena were exhibited by a vine manured with 0·5 kilogr. of silicate of potassa, 1·5 of phosphate of lime and potassa, and an equal weight of dried blood and goose-dung; it put forth in one year a shoot 11 metres in length, and yielded on nine shoots twenty-five bunches of grapes, while a similar vine which was not manured, produced a shoot only 4·6 metres long, with only four or six blossoms, which faded away before their full development.

Polstorff(2) has performed two series of experiments upon the nourishment of plants by mineral substances, and upon the influence which the form in which they are administered may have on their efficacy. The one series of experiments was made in limited spaces (boxes lined with lead), the other, in the open ground. In both cases barley was the subject of experiment. In the first series the plants were cultivated in brick-dust, and manured respectively with silicate of soda and potassa, carbonate of lime and potassa, phosphate of lime, soda and potassa, bone-earth, gypsum, phosphate of magnesia and ammonia, human excrements, ashes of the latter and ashes of barley. The general conclusions arrived at, were: firstly, that barley reaches its full development in a soil containing only the constituents of its ashes; secondly, that the amount of nitrogen in grain is therefore not dependent upon the soil; and lastly, that mineral manures are capable of producing entirely different results, according to the form in which their constituents are employed.—Excrements furnished a far greater produce than their ash when both were separately employed as manure.—When experimenting upon plants in the open field with the same mineral manures, he found that phosphate of magnesia and ammonia had no influence on the development of the grain, while it acted prejudicially upon the

(1) Compt. Rend. XXIV, 559; J. Pr. Chem. XLI, 454; Ann. Ch. Pharm. LXV, 126.
(2) Ann. Ch. Pharm. LXII, 192.

formation of straw, and that mineral manures containing no ammonia retarded vegetation.

Sea-sand as manure.

Sea-Sand as Manure.—J. Th. Herapath(1) has investigated two natural mineral products, which are extensively employed as manures. One of these is the calcareous sea-sand of the coasts of Devonshire and Cornwall, and which is best adapted for heavy clay soils; No. 1, was obtained from a small bay, near Ilfracombe; the other is the so-called *"Corallines"*,(2) constituting the chief ingredient of Barker's *submarine manure*, in the preparation of which it is calcined with salt, and afterwards mixed with night soil, decayed fish, &c.

	1.	2.
Water . . .	0·500	2·010
Soluble salts . .	0·300	trace
Organic matter . .	2·420	9·040
Carbonate of lime .	47·438	84·257
,, ,, magnesia.	0·097	1·373
Sulphate of lime . .	trace	trace
Phosphate of lime .	0·025	0·100
Sesquioxide of iron } .	0·460	0·820
Alumina . . . }		—
Fluoride of calcium .	—	trace
Sand and silica . .	18·760	2·400
	100·000	100·000

The soluble salts chiefly consist of chloride of sodium, sulphate of soda, sulphate of magnesia, with a portion of potassa.

No. 1. gave 0·1845 per cent, No. 2. 0·689 per cent of nitrogen, which correspond respectively to 0·224 and 0·837 ammonia.

Phosphate of Lime in Rocks.—The presence of phosphate of lime in plutonic rocks had been formerly pointed out by Fownes, and subsequently denied by Kersten. Deck(2), however, has lately analysed a mineral found in the compact basalt, from the Blaue Koppe, near the Meissner (electorate of Hesse), the composition of which is $Ca \left\{ \begin{matrix} Cl \\ F \end{matrix} \right. + 3\ (CaO,\ 3\ PO_5)$, *i. e.* that of apatite. The observation made by Fownes has thus received a new confirmation, the presence of phosphoric acid having previously been pointed out in hornblende rocks, from Arendal in Norway.

For the analyses of soils we refer to the article upon the cultivation of flax, and to the investigations of the ashes and organs of plants.

Investigations of the Ashes and Organs of Plants.—The investigation of the mineral constituents of plants, on account of their important technical relations, especially to agriculture, have continued to engage the attention of chemists. A glance at the numerous analytical results will at once show, that one direction

(1) Chem. Gaz. 1848, 342. (2) Chem. Gaz. 1848, 344.

Investigations of the ashes and organs of plants.

has been especially pursued and studied; namely, the influence of the soil upon the constitution of the ashes, and the distribution of their components through the various organs of the plants. It is evident that the laws regulating the mineral constituents of plants, which have been found to vary to so remarkable an extent, can be recognised only by a multiplication of the researches under all imaginable circumstances and conditions; by this means only we shall be enabled to discriminate between the accidental and characteristic influences, and safely eliminate the former. Hence it is highly gratifying that agricultural chemistry has taken this direction. At the same time most of the mineral constituents have been studied in their relation to the growth of plants, and in this manner the path has been opened to a more accurate knowledge of their development.

We here give all the analyses published during 1847 and 1848, with the exception of a series of important researches executed upon a very large scale by Way. These analyses which had not been completed when this summary was drawn up, will be communicated in next year's Report.

The appended table gives a synoptical view of the results of these analyses: we abstract from the individual papers only such remarks as may be necessary for the illustration of the numbers.

Walnut. — Glasson: Analysis of the walnut-ash (*Juglans regia*)(1). The author mentions only the results of the analysis without giving the method of incineration. He ought to have stated whether the ash investigated was that of the entire nut, or only that of a particular part of it. No. 12.

Radish, Coffee-Berry. —Thornton J. Herapath: Ash of the radish-root(2), and of the coffee-berry(3); both ashes were prepared according to Rose's method, *i. e.* carbonizing, exhausting the carbon, and incinerating the residue. No. 21 and 22.

Beta Vulgaris.—Carl Etti(4): Root of *Beta vulgaris italica* (No. 140); perfectly dried, and then incinerated in a platinum dish. The excess in the sum of the constituents arises from the circumstance of the carbonic acid not having been directly determined, but calculated upon the supposition that all disposable bases had remained in combination therewith after incineration.

(1) Ann. Ch. Pharm. LXI, 343; J. Pr. Chem. XLI, 91; J. Pharm. [3] XII, 74.
(2) Chem. Gaz. 1848, 279.
(3) Chem. Gaz. 1848, 159.
(4) Repert. Pharm. [2] XLV, 187.

ANALYSES OF ASHES.

Number	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.	31.	32.	33.	34.	35.	36.	37.	38	39.	40.	41.	42.	43.	44 a.	44 b.	Number.
	Rammelsberg.								Erdmann.			Glasson.	Rowney and How.					Namur.	Rammelsberg.		Herapath.		H. Watts.	R. Kane.								E. Wolff.																Wittstein.	
	Rape.				Peas.				Rape.	Peas.		Walnut.	Orange-tree.					Brassica rapa.	Flax.		Radish, root.	Coffee berries.	Hop-flowers.	Various specimens of prepared flax-stems, from Ireland, Holland, Belgium, &c.								Horse-chestnut.															Vitis hederacea.	
	Seed.		Straw.		Seed.		Straw.		Seed.	Seed.	Straw.		Root.	Stem.	Leaves.	Fruit.	Seed.	Leaves.	Seed.	Straw.											Young bark.	Young wood.	Leaf-stalks.	Young leaves.	Flower stalks.	Calyx.	Fila-ments.	Petals.	Young fruit.	Kernel of the ripe fruit from the "Wein-traube."	Green capsule of the fruit from the "Wein-traube."	Kernel of the fruit from the "Keuz-horst."	Green capsule of the fruit from the "Kreuz-horst."	Brown shell of the ripe fruit.	Green leaves.	
	Soluble portion	Insol. portion	Soluble portion	Insol. portion	Soluble portion	Insol. portion	Soluble portion	Insol. portion																																				
Potassa	3·08	22·10	7·53	0·60	7·47	35·62	6·74	1·46	22·70	40·70	33·30	27·12	15·43	11·69	16·51	36·42	40·28	29·53	28·34	35·44	18·77	16·51	19·41	7·70	22·90	22·30	25·79	18·41	9·78	6·33	5·23	13·34	24·93	18·45	47·15	45·59	44·80	44·09	44·16	48·53	47·48	36·67	54·02	37·63	23·97	Potassa.
Soda	—	—	18·63	1·19	—	—	9·90	2·60	—	—	1·50	—	4·52	3·07	1·68	11·42	0·92	2·11	1·63	3.71	18·48	6·79	0·70	19·19	—	14·11	0·43	10·91	9·82	6·35	—	—	—	—	—	—	—	—	—	—	—	—	—	—	12 01	Soda.
Lime	—	12·91	—	20·05	0·03	4·74	0·29	30·24	14·65	2·21	19·20	21·59	49·89	55·13	56·38	24·52	18·97	25·51	8·45	21·00	13·51	27·66	14·15	15·38	16·48	18·52	19·10	18·37	12·33	22·70	47·70	32·58	18·04	25·48	7·65	9·54	10·81	10·68	8·37	9·42	6·64	10·20	8·14	13·54	20 26	Lime.
Magnesia	—	11·39	—	2·56*	0·15	7·91*	0·15	6·78*	12·03	7·03	3·90	7·72	6·91	6·34	5.72	8·06	8·74	7·45	13·41	5·57	1·39	5·94	5·34	3·44	3·33	3·93	3·65	3·02	7·79	4·06	1·06	3·70	2·53	2·27	1·08	4·57	2·43	3·01	1·99	0·48	0·86	0·36	0·68	1·94	8·06	Magnesia.
Alumina	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1·18	0·44	0·44	0·72	—	1·44	6·08	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0·07	Alumina.
Sesquioxide of iron	—	0·62	—	—	—	—	—	—	—	—	—	0·73	1·02	0·57	0·52	0·46	0·80	—	} 2·00	1·16	—	—	2·41	4·50	1·52	1·10	2·28	2·36	—	13·52	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0·67	Sesquioxide of iron.
Sesquioxide of manganese	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—		0 28	—	—	—	trace	trace	trace	—	—	—	1·09	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Sesquioxide of manganese.
Sulphuric acid	0·53	—	7·60	—	0·44	—	5·30	1·71	0·80	4·17	6·60	2·27	5·78	4·64	4·43	3·74	5·10	4·00	0·10	6·19	3·75	1·27	8·28	6·28	6·17	6·83	12·09	9·68	2·65	8·93	—	—	3·13	7·92	2·90	2·90	—	—	3·08	1·36	0·76	1·02	1·22	2·94	3·09	Sulphuric acid.
Hydrochloric acid	0·11	—	19·93	—	1·96	—	7·15	—	—	—	—	—	—	—	—	—	—	—	0·06	3·48	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Hydrochloric acid.
Chlorine	—	—	—	—	—	—	—	—	—	—	13·46	—	—	—	—	—	—	—	—	—	—	—	2·26	—	—	—	—	—	2·41	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1·80	Chlorine.
Silicic acid	—	1·11	—	0·48	0·79	0·33	—	0·62	—	—	7·60	1·13	1·75	1·22	4·83	0·44	1·13	6·14	0·40	2·49	0·26	0·44	17·38	3·05	3·41	2·68	3·03	5·33	21·35	24·98	0·70	1·97	0·87	4·27	0·60	1·31	0·58	1·13	0·64	0·16	0·43	0·15	0·37	0·69	5·00	Silicic acid.
Carbonic acid	0·42	1·78	4·77	11·54	—	—	4·75	12·61	—	—	5·20	2·93	—	—	—	—	—	19·50	1·59	8·55	23·81	—	11·01	20·60	25·23	16·38	9·89	13·75	16·95	4·11	37·92	24·16	16·78	12·89	17·64	22·17	21·47	21·58	15·75	17·83	24·61	13·07	27·97	18·88	9·97	Carbonic acid.
Phosphoric acid	1·74	44·21	—	4·76	2·10	38·46	0·64	8·57	47·57	44·42	6·90	35·61	13·47	17·09	3·27	11·07	23·24	1·17	44·02	12·13	8·99	40·75	14·64	11·21	11·80	8·81	10·98	11·06	10·84	7·00	3·75	14·58	12·32	19·48	14·07	12·94	15·33	13·31	17·55	18·74	3·98	19·15	5·40	15·36	15·10	Phosphoric acid.
Phosph. of sesquiox. of iron	—	—	—	—	—	—	—	—	2·25	1·47	1·40	—	—	—	—	—	—	1·33	—	—	0·13	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Phosph. of sesquiox. of iron.
Phosph. of lime, of magnesia, and of sesquiox. of iron	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Phosph. of lime, of magnesia, and of sesquiox. of iron.
Chloride of potassium	—	—	—	—	—	—	—	—	—	—	—	0·80	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3·64	9·67	21·40	9·24	8·91	3·88	4·58	6·20	8·46	3·48	15·42	19·38	2·20	9·02	—	Chloride of potassium.
Chloride of sodium	—	—	—	—	—	—	—	—	—	—	—	—	1·18	0·25	6·66	3·87	0·82	3·25	—	—	10·89	0·64	—	8·21	8·70	4·58	12·75	5·65	—	0·90	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Chloride of sodium.
Charcoal	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2·95	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Charcoal.
Sand	—	—	—	—	—	—	—	—	—	—	3·80	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Sand.
Total	5·88	94·12	58·46	41·54	12·94	87·06	34·92	65·08	100·00	100·00	102·86	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	99·99	99·99	99·99	99·98	100·00	99·97	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	Total.
Percentage of ash	4·51		5·21		3.28		4·15		4·03	3·34	8·28	0·667	4·48	2·74	13·73	3·94	3·30	—	4·219	3·600	8·285	3·3	6·5	4·237	5·434	3·670	4·540	5·151	5·00	5·572	7·85	1·05	13·38	7·62	11·36	6·65	6·56	6·10	4·39	3·36	7·29	2·26	4·53	1·70	1·56	Percentage of ash.

* With sesquioxide of iron.

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Number	45.	46.	47.	48.	49.	50.	51.	52.	53.	54.	55.	56.	57.	58.	59.	60.	61.	62.	63.	64.	65.	66.	67.	68.	69.	70.	71.	72.	73.	74.	75.	76.	77.	78.	79.	80.	81.	82.	83.	84.	85.	86.	87.	88.	Number.
	Crasso.									Walz.			John Pitkin Norton.																																	
	Unripe blue grapes. Ash of the juice.	Ripe blue grapes. Ash of the juice.	Ripe blue grapes. Ash of the juice.	Ripe green grapes. Ash of the juice.	Blue grapes. Ash of the skin.	Green grapes. Ash of the skin.	Blue grapes. Ash of the seed.	Green grapes. Ash of the seed.	Small Burgundy vines. Ash of the wood.	Cleven vines, with leaves.	Riesling vines, with leaves.	Drollingen vines, with leaves.	Unripe oats. Leaves. 4. June.	11. June.	18. June.	25. June.	2. July.	9. July.	16. July.	Stems. 4. June.	11. June.	18. June.	25. June.	2. July.	8. July.	16. July.	Joints. 16. July.	Chaff. 16. July.	Unthrashed corn. 2. July.	9. July.	16. July.	Ripe oats. Straw. Top.	Middle.	Bottom.	Leaves.	Chaff.	Husks (chaff) of: Potato oats.	Hopeton oats, from: Northumberland.	Wigtonshire.	Ayrshire.	Grains of: Potato oats, from Northumberland.	Hopeton oats, from: Northumberland.	Wigtonshire.	Ayrshire.	
Potassa	66·33	65·04	71·85	62·74	41·65	46·89	27·87	29·45	44·15	7·04	6·31	11·96	24·60	23·51	26·21	28·10	18·78	16·09	18·35	—	—	—	—	—	—	—	—	—	—	—	—	} 38·55*	21·80	40·17	14·80	7·93	2·23	6·33	5·55	5·30	} 31·56	20·96	—	20·65	Potassa.
Soda	0·33	0·42	1·20	2·66	2·13	1·62	—	—	3·45	9·20	7·13	3·41	—	—	—	—	—	—	—	2·40	4·22	3·74	2·42	2·64	1·60	4·12	4·75	4·58	2·70	5·40	6·76	7·02	7·23	6·06	6·99	4·55	4·30	1·95	4·31	2·03	5·32	6·57	10·41	10·28	Soda.
Lime	5·20	3·37	3·39	5·11	20·31	21·73	32·18	35·57	36·04	21·72	24·54	31·07	8·44	7·24	7·33	6·74	6·91	5·93	5·13	2·40	4·22	3·74	2·42	2·64	1·60	4·12	4·75	4·58	2·70	5·40	6·76	7·02	7·23	6·06	6·99	4·55	4·30	1·95	4·31	2·03	5·32	6·57	10·41	10·28	Lime.
Magnesia	3·27	4·74	3·97	3·95	6·02	4·45	8·53	8·59	4·77	6·81	4·76	9·22	5·33	3·11	3·47	3·06	2·39	2·35	1·63	0·88	3·20	2·20	2·58	1·17	2·27	1·47	4·51	3·10	3·44	4·52	2·94	2·84	2·91	2·07	2·55	1·84	2·35	0·38	1·01	0·64	8·69	11·00	9·98	7·82	Magnesia.
Alumina	—	—	—	—	—	—	—	—	—	1·15*	0·91	1·00	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Alumina.
Sesquioxide of iron	0·73	0·43	0·09	0·40	2·11	1·97	0·45	0·65	0·54	—	—	—	0·61	0·52	0·72	0·99	0·40	0·34	0·55	0·39	0·30	0·40	0·58	0·88	0·68	0·62	1·02	1·50	0·39	0·21	0·35	0·30	1·40	0·61	0·32	—	0·32	1·58	1·61	1·80	0·88	0·38	5·08	3·85	Sesquioxide of iron.
Sesquioxide of manganese	0·82*	0·75	0·10	0·30	0·76	0·51	0·35	0·45	0·11	0·035	0·135	0·175	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0·92	0·86	0·72	—	—	1·25	0·42	Sesquioxide of manganese.
Sulphuric acid	—	5·54	3·65	4·89	3·48	3·88	2·40	2·61	1·82	1·27	1·36	1·13	11·74	12·85	10·59	7·88	9·50	6·45	13·05	6·15	7·82	8·51	4·87	7·98	9·09	7·84	27·94	9·90	10·35	12·78	16·42	—	18·45	16·10	14·89	5·32	4·30	9·61	5·01	4·90	—	17·37	—	—	Sulphuric acid.
Hydrochloric acid	5·19	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Hydrochloric acid.
Chlorine	0·70	1·03	0·47	0·70	0·49	0·71	0·27	0·35	0·85	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Chlorine.
Silicic acid	1·99	2·10	1·19	2·18	3·46	2·57	0·95	1·27	1·22	3·54	3·41	3·25	16·58	28·54	30·31	36·50	47·62	58·28	58·22	16·29	14·32	20·41	28·08	36·64	32·39	34·85	13·23	56·38	24·40	17·05	26·05	5·13	7·34	5·03	5·90	11·99	5·79	4·46	2·91	1·61	0·89	1·29	—	—	Silicic acid.
Carbonic acid	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Carbonic acid.
Phosphoric acid	15·38	16·59	14·07	17·04	19·57	15·66	27·00	21·05	7·05	—	—	—	16·16	10·57	10·12	8·76	6·92	6·44	2·91	16·15	13·96	12·55	7·81	2·21	5·57	6·31	9·03	7·26	14·02	20·09	15·19	—	—	—	—	—	0·66	1·04	2·65	1·80	49·19	38·48	46·26	50·44	Phosphoric acid.
Phosph. of sesquiox. of iron	—	—	—	—	—	—	—	—	—	2·21	2·38	2·47	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Phosph. of sesquiox. of iron
Phosph. of lime, of magnesia, and of sesquiox. of iron	—	—	—	—	—	—	—	—	—	11·17†	19·63	9·25	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Phosph. of lime, of magnesia, and of scsquiox. of iron.
Chloride of potassium	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2·84	3·03	0·78	6·13	5·84	—	—	—	—	—	—	—	—	Chloride of potassium.
Chloride of sodium	—	—	—	—	—	—	—	—	—	1·27	1·73	1·65	16·34	13·54	11·30	7·56	7·92	4·09	0·30	32·66	34·65	24·94	24·57	11·62	17·82	4·46	0·60	2·01	10·37	8·10	0·61	—	3·03	15·36	2·29	5·11	2·39	0·24	—	—	0·35	0·49	—	—	Chloride of sodium.
Charcoal	—	—	—	—	—	—	—	—	—	} 34·56‡	} 27·68	} 25·30	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2·37	0·40	—	—	5·32	1·03	Charcoal.
Sand	—	—	—	—	—	—	—	—	—				—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Sand.
Total	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	99·80	99·88	100·05	99·59	100·14	99·97	100·14	99·86	99·92	99·24	99·77	99·40	99·52	100·33	100·29	100·12	98·59	99·46	99·69	99·99	98·33	98·47	99·30	98·66	99·80	98·83	98·10	99·33	97·86	98·85	98·27	98·89	Total.
Percentage of ash	0·259	0·340	0·409	0·290	3·745	4·321	2·776	2·837	3·692	6·19	7·74	6·00	2·16	1·86	1·63	2·35	2·24	2·81	3·06	1·36	1·28	1·28	1·40	1·28	1·40	1·52	—	2·72	0·94	1·02	1·17	49·5	6·11	5·33	—	—	—	—	—	—	2·22	2·14	—	—	Percentage of ash.

* In this and the following analyses (to No. 53 incl.) protosesquioxide of manganese.

* In No. 54, 55, and 56, phosphate of alumina.
‡ " " " " " " " lime.
‡ " " " " " " charcoal and sand, together with CO_2 and loss.

* With Na Cl and SO_3.
† Insol. silicic acid.

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ANALYSES OF ASHES.

Number	89.	90.	91.	92.	93.	94.	95.	96.	97.	98.	99.	100.	101.	102.	103.	104.	105.	106.	107.	108.	109.	110.	111.	112.	113.	114.	115.	116.	117.	118.	119.	120.	121.	122.	123.	124.	125.	126.	127.	128.	Number.
	Ludwig	Thornton John Herapath.												Thomas Richardson.																											
	Sarsaparilla.	Mulberry tree.												Pine apple.		Asparagus.	Leek.		Fig, entire fruit.	Walnut.		Cucumber.	Broccoli.		Cauliflower.	Radish.		Chestnut, entire fruit.	Strawberry, entire fruit.	Orange, entire fruit.	Rhubarb.		Spinage.	Kidney beans.	Pea, pods.	Plum, entire fruit.	Orleans plum.					
		Sap of			Woody matter of			Cellulose of			*Matière incrustante.*			Eutire fruit.	Crown.		Bulb.	Stem.		Keruel.	Capsul.		Root.	Leaves.		Root.	Leaves.				Stem.	Leaves.						Cuticle of the fruit.	Pulp of the fruit.	Kernel.	Seed-shell.	
		Berries	Leaves.	Branches.	Berries	Leaves.	Branches.	Berries	Leaves.	Branches.	Berries	Leaves.	Branches.																												
Potassa	34·93	32·23	34·57	22·73	2·41	7·29	10·80	2·21	2·66	9·40	14·13	7·68	10·86	49·42	19·66	6·01	32·35	13·98	28·36	31.11	23·10	47·42	47·16	22·10	34·39	21·16	5·05	39·36	21·07	38·72	59·59	14·47	9·69	36·83	22·31	59·21	58·86	54·59	26 52	21·69	Potassa.
Soda	—	18·91	11·69		10·76									—	—	34·21	8·04	14·43	24·14	2·25	2·74	—	—	7·55	14·79	—	11·09	19·18	27·01	7·64	0·46	31·77	34·96	18·40	17·99	0·54	3·52	8·72	1·94	7·69	Soda.
Lime	13·60	10·45	11·13	41·54	12·53	39·12	42·63	4·03	3·99	27·25	13·51	42·05	40·62	12·15	21·28	4·39	12·66	25·10	18·91	8·59	30·57	6·31	4·70	26·44	2·96	8·78	27·90	7·84	14·21	22·99	10·04	3·95	13·11	7·75	31·08	10·04	8·25	4·86	8·49	28·06	Lime.
Magnesia	4·55		0·71	trace	—	0·57	trace	—	trace	—	—	0·62	—	8·80	6·81	3·03	2·70	trace	9·21	13·03	4·13	4·26	3·93	3·43	2·38	3·53	7·08	7·84	trace	6·55	—	5·59	5·29	6·33	9·54	5·46	9·29	4·69	16·17	3·77	Magnesia.
Alumina	5·11	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Alumina.
Sesquioxide of iron	4·60	—	—	—	—	—	—	—	—	48·664	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Sesquioxide of iron.
Sesquioxide of manganese	0·30	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5·48	—	—	—	—	—	—	—	—	—	—	—	—	Sesquioxide of manganese.
Sulphuric acid	3·26	7·12	14·92	trace	0·17	6·02	8·40	trace	trace	—	0·19	6·52	8·89	trace	5·26	4·13	8·34	16·50	6·73	trace	14·96	4·60	10·35	16·10	11·16	7·71	9·64	3·88	3·15	2·95	1·89	9·52	9·30	3·96	6·96	5·83	1·96	3·23	7·11	6·61	Sulphuric acid.
Hydrochloric acid	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Hydrochloric acid.
Chlorine	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Chlorine.
Silicic acid	7·95	2·34	6·89	—	15·74	21·87	15·63	9·25	35·92	14·68	16·35	20·52	15·73	4·02	6·09	13·47	3·04	19·77	5·93	—	14·43	7·12	0·69	1·83	1·92	8·17	8·22	2·32	12·05	5·24	2·77	2·33	3·16	4·09	0·29	2·36	0·81	3·15	2·38	2·57	Silicic acid.
Carbonic acid	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Carbonic acid.
Phosphoric acid	10·52	1·45	0·34	trace	—	—	—	—	—	—	—	—	—	4·08	—	18·51	15·09	—	—	42·53	—	14·97	24·83	16·62	25·84	40·09	6·07	7·33	8·59	14·17	12·83	30·04	7·89	14·60	10·59	12·26	9·85	15·44	33·05	25·24	Phosphoric acid.
Phosph. of sesquiox. of iron.	—	—	—	—	11·49	3·61	6·62	44·20	25·84	—	8·85	1·77	0·05	2·93	7·35	3·31	13·29	10·06	2·76	2·49	10·07	2·06	2·12	6·21	3·67	2·19	16·45	1·95	11·12	1·74	2·77	2·33	8·67	5·24	1·16	6·04	7·45	4·80	3·83	4·37	Phosph. of sesquiox. of iron.
Phosph. of lime, of magnes. and of sesquioxide of iron.	—	26·14	16·44	28·47*	46·68	21·51	16·28	40·30	31·59	—	46·72	22·84	23·84	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Phosph. of lime, of magnes. and of sesquioxide of iron.
Chloride of potassium	15·17	—	—	—	—	—	—	—	—	—	—	—	—	0·88	31·11	—	—	—	—	—	—	4·19	6·22	—	—	1·29	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Chloride of potassium.
Chloride of sodium	—	1·36	3·31	7·26	0·21	—	trace	—	—	—	0·25	—	—	17·01	2·42	12·94	4·49	trace	4·02	trace	—	9·06	trace	—	2·78	7·07	8·50	4·82	2·78	trace	8·84	trace	7·93	2·80	trace	—	—	0·62	0·49	trace	Chloride of sodium.
Charcoal	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Charcoal.
Sand	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Sand.
Total	100·00	100·00	100·00	100·00	100·00	100.00	100·00	100·00	100·00	100.00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	Total.
Percentage of ash	2·36	11·28	12·83	5·83	3·78	6·11	1·92	1·02	1·09	0.39	4·82	7·79	2·43	—	—	0·47†	0·46	0·84	—	—	—	0·63	1·01	1·70	0·71	6·43	2·76	0·99	0·41	—	0·41	1·23	2·03	0·68	0·69	0·40	0·89	0·31	1·64	0·24	Percentage of ash.

* This number, as well as all those following up to No. 101 inclusive, represents only phosphate of lime.

† This number, as well as all those belonging to Richardson's analyses, refer to 100 parts of the plant in the natural (undried) state.

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Number	129.	130.	131.	132.	133.	134.	135.	136.	137.	138.	139.	140.	141.	142.	143.	144.	145.	146.	147.	148.	149.	150.	151.	152.	153.	154.	155.	156.	157.	158.	159.	160.	161.	162.	163.	164.	165.	Number.
	Thomas Richardson.											C. Etti.	G. Reich.		Th. Dickson.																							
	Cherry,		Pear,	Apple,											Ale														Porter										
	Entire fruit.	Stalk.	Entire fruit.		Artichoke.	Lettuce.	Endive.	Strawberry.	Sellery.	Carrots	Parsnips.	*Beta vulgaris* (*italica*) Root	Fossil wood of *Pinites succinifer.*	Fossil fircones.	Scotch.	Scotch.	Scotch.	Scotch.	Scotch.	Scotch.	Scotch.	Scotch.	Scotch.	Scotch.	Scotch.	Scotch.	for exportation.	from London.	from London.	from London.	from Dublin.	Scotch.	from London.	from London.	from Dublin.	Scotch.	
															Price per Gallon.																						
															2s.	3s.	3s.	2s. 6d.	2s. 6d.	2s.	2s.	1s. 9d.	1s. 6d.	1s. 6d.	1s. 3d.	1s.	1s.	3s.	3s.	3s.	2s. 6d.	2s. 6d.	2s.	2s.	2s.	2s.	2s.	
Potassa	51·85	42·66	54·69	35·68	24·04	46·01	37·87	38·65	22·07	32·17	36·12	19·51	4·04	5·22	24·55	26·60	20·92	22·12	15·91	23·71	10·48	27·56	3·16	29·83	31·91	17·57	11·63	19·42	26·36	31·14	11·94	32·04	20·88	16·03	22·88	21·38	18·86	Potassa.
Soda	1·12	6·17	8·52	26·09	5·52	5·29	12·12	9·27	—	5·00	3·11	21·12	—	—	34·43	35·71	53·08	33·48	42·76	46·08	48·39	40·52	58·51	38·39	20·87	31·28	24·86	37·13	21·78	32·93	24·33	42·72	38·77	50·82	30·52	24·01	33·76	Soda.
Lime	7·47	22·26	7·98	4·08	9·56	6·05	12·03	12·20	13·11	12·34	11·43	3·25	16·65	10·45	1·20	0·55	0·17	0·86	0·71	1·98	0·26	1·34	0·87	0·74	6 69	1·54	0·65	1·24	6·89	1·51	3·87	1·54	1·62	1·31	1·33	0·83	1·34	Lime.
Magnesia	5·46	2·71	5·22	8·75	4·14	2·17	1·77	5·85	5·82	5·73	9·94	6·96	6·46	7·24	0·40	0·23	0·33	4·64	0·96	5·65	2·27	1·63	1·03	0·50	1·56	2·16	0·06	0·53	0·39	0·12	0·66	0·51	0·17	0·10	1·27	1·10	1·39	Magnesia.
Alumina	—	—	—	—	—	—	—	—	—	—	—	—	12·43	10·41	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Alumina.
Sesquioxide of iron	—	—	—	—	—	—	—	—	—	—	—	0·09	6·05	5·34	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Sesquioxide of iron.
Sesquioxide of manganese	—	—	—	—	—	—	—	—	1·92	trace	0·89	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Sesquioxide of manganese.
Sulphuric acid	5·09	2·98	5·69	6·09	5·18	3·89	5·21	5·89	5·58	3·26	6·50	2·46	14·15	16·24	2·13	2·27	1·61	3·21	4·66	0·13	5·56	7·01	6·28	2·77	2·66	7·07	14·57	19·16	6·61	4·64	12·20	1·57	6·36	4·53	4·97	2·76	2·18	Sulphuric acid.
Hydrochloric acid	—	—	—	—	—	—	—	—	—	—	—	—	0·68	0·46	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Hydrochloric acid.
Chlorine	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Chlorine.
Silicic acid	9·04	2·59	1·49	4·32	7·02	20·23	24·62	2·58	3·85	4·78	4·10	—	21·02	26·22	6·54	4·86	7·08	4·59	8·57	7·34	11·05	5·88	6·07	5·38	10·00	14·91	19·05	9·98	8·25	13·93	12·93	6·94	13·28	9·52	15·24	19·74	18·60	Silicic acid.
Carbonic acid	—	—	—	—	—	—	—	—	—	—	—	29·10	3·22	1·10	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Carbonic acid.
Phosphoric acid	14·21	14·89	14·28	12·34	36·23	8·52	—	15·58	11·58	10·39	18·66	2·39	15·30	17·74	25·66	20·00	12·51	24·17	16·35	12·05	15·33	7·92	17·62	16·83	16·85	16·66	10·92	5·98	20·58	9·26	12·54	7·89	18·77	10·28	12·85	19·99	12·48	Phosphoric acid.
Phosph. of sesquiox. of iron.	3·74	2·35	1·96	2·65	4·74	trace	6·36	8·65	2·66	3·02	3·71	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Phosph. of sesquiox. of iron.
Phosph. of lime, of magnes. and of sesquioxide of iron.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Phosph. of lime, of magnes. and of sesquioxide of iron.
Chloride of potassium	—	—	—	—	—	—	—	—	33·41	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Chloride of potassium.
Chloride of sodium	2·02	2·39	trace	—	3·57	7·82	trace	1·23	—	9·62	5·54	2·35	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Chloride of sodium.
Charcoal	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Charcoal.
Sand	—	—	—	—	—	—	—	—	—	—	—	14·11*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Sand.
Total	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	105·59	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	Total.
Percentage of ash.	0·43	2·37	0·41	0·27	1·17	0·87	1·37	0·39	1·07	0·79	1·49	1·03	4·96	5·22	4·800	3·395	3·797	5·475	3·500	4·621	3·595	4·673	4·152	3·885	8·186	7·626	12·035	8·666	7·863	8·822	6·864	5·720	6·050	9·001	14·579	11·113	6·054	Percentage of ash.

* Together with silicic acid.

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Brassica Rapa.—J. Namur: Ash of the leaves of *Brassica rapa*(1). No. 18. Without farther statements. Brassica rapa.

Flax.—C. Rammelsberg: Analysis of the ash of seeds, and also of the stem of the flax-plant(2). No. 19 and 20. Without farther statements.

Orange-tree.—Thomas Rowney and H. How: Analysis of the ash of the orange-tree(3). No. 13 to 17 inclusive.—The materials for this investigation came from the plantation of Mr. Da Cumara, in the Island of St. Michael. The ash was prepared by direct incineration in an open crucible, the fruit being previously deprived of the seeds and dried. In order to restore the partially reduced sulphates, the ash was ignited in a platinum dish with a portion of protoxide of mercury. The analyses confirm the observation previously made by Saussure, that the mineral constituents accumulate chiefly in that part of the plant in which the vegetative process exhibits the greatest activity, the quantity in the leaves being from three to four times larger than that in the fruit, seed, and stem. Lime prevails in the roots and in the stem, while the alkalies predominate in the fruit and in the seed. The proportion of phosphoric acid in the seed is considerable, although smaller than the quantity found by Souchay in the otherwise similarly constituted ash of the seed of the citron.

Rape and Pea.—C. Rammelsberg has investigated the distribution of the inorganic constituents in the individual organs of plants, and in the case in question, of the rape and pea(4), No. 1 to 8 inclusive.—We may remark, that in the seeds of both plants potassa is exclusively present, while, on the contrary, the straw is found to contain also soda, the latter occurring even in predominating quantity. The earths prevail in the straw, and the phosphoric acid in the seeds. The straw contains considerably more carbonic acid than the seeds, namely, 8 times the quantity in the rape, and 22 times the quantity in the pea.—The preparation of the ash was effected according to Rose's method. The portion obtained by exhausting the carbon with boiling water, is designated in the table "soluble part," and that which was prepared by incinerating the residuary carbon is termed "insoluble part." The author observes, "Of course, this

(1) Ann. Ch. Pharm. LIX, 264; Phil. Mag. [3] XXXIII, 78; J. Pharm. [3] XIII, 51; Froriep's Not. 1848, 151; J. Pr. Chem. XL, 123.

(2) J. Pr. Chem. XLI, 350.

(3) Phil. Mag. [3] XXXI, 271; J. Pr. Chem. XLII, 322; Chem. Gaz. 1847, 227.

(4) Pogg. Ann. LXXI, 148; J. Pr. Chem. XLI, 84.

Rape and pea.

(the dissolved part) is not the entire portion of that which is actually soluble, inasmuch as the peculiar structure of vegetal charcoal prevents complete exhaustion."

In addition to the above analyses, O. L. Erdmann (No. 9. to 11. inclusive) has made a communication regarding the same plant(1), in anticipation of a more extensive investigation, which will be published at a future period. His results confirm, in general, the conclusions arrived at by Rammelsberg, but at the same time point out remarkable differences occasioned by the locality of cultivation.

Growth of the Vetch.—J. Schleiden and E. Schmid(2) have studied the development of the vetch (*Vicia sativa*), by comparing its elementary composition at diffcrent periods of its growth. The seeds were sown on the 15th of May, and the plants gathered for experiment respectively on the 2nd of June (first period), 12th of July (second period, in flower), 6th of August (third period, commencement of maturation), and 3rd of September (fourth period, perfect maturation). The weights are, in each case, average numbers obtained by weighing several hundred specimens, and to a certain extent represent the weight of the mean, or normal plant.—In the first period the weight of the normal plant, to that of the original seed, stood in the relation of 1 : 1·29; the absolute quantity of carbon, hydrogen, and oxygen, was about a third less, and that of the ash about 47 per cent more than in the seed, while the absolute amount of nitrogen had remained unaltered. In the following periods the absolute weight, both of the entire plant and of its individual constituents, steadily increased. From the first to the fourth period the absolute amounts of nitrogen increased 32 times, that of carbon about 67, of hydrogen about 65, of oxygen 71, and of ash about 70 times the original quantities.—During the growth the distribution of these constituents changes very considerably: the nitrogen in the stalks diminishes from 9·11 to 2·36 per cent; the ash-constituents, in the latter period, pass more and more into the seeds and pods. For details we refer to the original paper.

Hops.—H. Watts(3): Analysis of the Ash of the Hop; No. 23. The hops were of that variety which is usually termed "*the grape*," and were cultivated on heavy clay soil, at Hawkhurst, in Kent. The

(1) J. Pr. Chem. XLI, 89.
(2) From the 3. Programm des Physiol. Instituts zu Jena, in Pogg. Ann. LXXI, 138.
(3) Phil. Mag. [3] XXXII, 54.

crop was above the average, namely, 12 cwt. of dried saleable hops (strobiles) per acre. In the condition in which they were incinerated, 11·5 per cent of moisture could be expelled by drying at 100°. By treating the ash with boiling water, the mean of two experiments gave 35·77 per cent of soluble matter, while 64·23 per cent remained undissolved. The soluble portion consisted of chloride of sodium, chloride of potassium, carbonate, sulphate, silicate, and phosphate of potassa; the insoluble matter of carbonates of lime and magnesia, phosphate of lime, magnesia, alumina, and sesquioxide of iron, as well as carbon and sand. From the amount of ash and produce of hops, Watts calculates, that each crop withdraws from the soil 87 lbs. of mineral constituents per acre, including from 12 to 13 ozs. of phosphoric acid, 17 lbs. of potassa, and 15 lbs. 10 ozs. of silica. This explains the very exhausting action of hops upon soils. Hops.

Horse-Chestnut.—A contribution towards the solution of the question, in what manner the proportionate weights of the mineral constituents of plants are modified by their passage from one organ to another, and how they are distributed in the various organs, has been communicated by E. Wolff, in a detailed investigation of the mineral constituents contained in the various parts of the horse-chestnut tree (*Aesculus hippocastanum*) (1), No. 31. to 44*a*. inclusive. In order to deprive the results of too local a character, the plants investigated were selected from two stations: 1. From the "*Weintraube*" coffee-house, at Halle, which is situated upon a stony porphyry soil; 2. From the "*Kreuzhorst*," near Magdeburg, on moist forest-land, which is rich in humus, frequently flooded, and in which the chestnut grows more luxuriantly than in the former soil. The determination of the moisture, in the various parts of the plant, gave the following results:

Part of the plant.	Dry substance.	Water.	Part of the plant.	Dry substance.	Water.
1. Wood . . .	51·55	48·45	10. Unripe fruit . .	18·99	81·01
2. Inner-bark . .	45·02	54·98	11. Ripe fruit . . .	—	—
3. Outer-bark . .	—	—	12. Perisperm . . .	47·12	52·88
4. Leaf-stalks . .	15·96	84·04	13. Ditto	50·33	49·67
5. Leaves . . .	24·59	75·41	14. Green capsule . .	17·30	82·70
6. Flower-stalk .	14·71	85·21	15. Ditto	18·88	81·12
7. Calyx	16·84	83·16	16. Brown capsule .	36·00	64·00
8. Filaments . .	16·40	83·60	17. Ditto	39·09	60·91
9. Petals . . .	13·55	86·67			

The method, according to which the mineral constituents were

(1) J. Pr. Chem. XLIV, 385.

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extracted from the plant, was essentially that of Rose and Erdmann. Wolff first carbonized the substance at the lowest possible temperature in a muffle heated below redness; he then successively exhausted the carbon, first with water, then with dilute hydrochloric acid; the carbonaceous residue was then dried, and completely incinerated in the muffle. The ashes obtained in the last stage of the process, in most cases very insignificant, were likewise exhausted with hydrochloric acid, the acid solutions united, and separate analyses performed of the aqueous extract, of the acid extract, and of the insoluble residues.

The ratio of the portion of mineral constituents soluble in hot water, to that which is insoluble, is centesimally expressed as follows:

Part of the plant.	In water.		Part of the plant.	In water.	
	Soluble.	Insoluble.		Soluble.	Insoluble.
Young bark . .	11·35	88·65	Petals	72·20	27·80
Young wood .	29·21	70·79	Young, unripe fruit . .	77·77	22·23
Leaf-stalks . .	59·38	40·62	Ripe fruit	78·85	21·15
Young leaves .	39·77	60·23	Green capsule of the fruit	85·37	14·63
Flower-stalks .	81·16	18·84	Ditto	81·96	18·04
Calyx	72·70	27·30	Perisperm	77·02	22·98
Filaments . .	72·22	27·78	Brown capsule	68·77	31·23

The author then passes on to a comprehensive calculation of the capacity of saturation for organic acids exhibited by the ash, according to the sum of the oxygen contained in that portion of the bases, which remains disposable after deduction of the quantities required by the mineral acids. For details we refer to the original; we may mention, however, that calculation gave, in round numbers, for the bark 27, for the wood and leaves 24, for the leaf-stalks and the brown capsule of the fruit 21, and for all other parts 18 per cent of disposable oxygen. The author farther points out, that this portion of the oxygen remains unaltered for the same parts of the plant cultivated in different places and on distinct kinds of soils, and that no mutual replacement of the bases takes place. Thus the quantity, f. i., of carbonic acid combined with the bases was found to be:

	Perisperm.		Green capsule of the fruit.	
	From the "Weintraube."	From the "Kreuzhorst."	From the "Weintraube."	From the "Kreuzhorst."
Lime	5·69	4·58	6·62	6·90
Magnesia	1·29	1·41	1·69	1·20
Potassa	93·02	94·01	91·69	91·90
Amount of oxygen in the bases.	17·93	17·83	18·14	18·05

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We abstract the following results respecting the distribution of the individual constituents of the ash. *Lime* prevails very perceptibly in the bark, diminishing, on the one hand, in the wood, leaf-stalks, and leaves, and on the other hand, in a still more decided manner towards the organs of inflorescence and fructification. *Potassa* varies in an opposite manner. *Magnesia,* which occurs in very subordinate quantity, exhibits no decided character. The same observation applies to *sulphuric acid.* Still it is worthy of remark that, while a small quantity of this acid is met with in the leaves, it is entirely absent in the bark and wood, although these organs are placed between the soil and the leaves. *Chloride of potassium* accumulates chiefly in the leaf-stalks, and organs of fructification; in the latter, however, it appears to be greatly influenced by the nature of the soil, inasmuch as in one case it predominates in the perisperm, whilst in another it is chiefly found in the exterior capsule. The amount of *carbonic acid* decreases from the wood and bark towards the leaves, but increases towards the flowers and fruit, the latter being, in accordance with all the observations hitherto made, the principal seat also of *phosphoric acid* (of phosphorus). With regard to silicic acid, it may be observed that, in general, scarcely more than traces are present.

In considerations of this nature, respecting the distribution of the ash-constituents in the various organs of a plant, we must bear in mind that all the numbers in question have only a relative signification. A true exposition, representing the state of things as actually existing in nature, could only be given by ascertaining the absolute weight of each organ of a tree, and taking these weights into the calculation.

E. Wolff next proceeds to a comparison of the total amount of mineral constituents contained in the individual organs; in the first place, of those occurring in the bark, and in the wood. He shows that the ash of the bark may be considered as the ash of the wood (0·3 part), with a large excess of carbonate of lime (0·7 part). The 0·3 of the mineral constituents, occurring both in the ash of the bark, and in that of the wood, the author considers as the normal mixture of mineral matter contained in the sap which ascends from the roots, and he takes this quantity as the basis of his farther speculative researches into the ashes of the other organs. The composition of this normal sap-ash was found to be: lime 35·71, magnesia 4·72, potassa 23·52, chloride of potassium 16·26, phosphoric acid 16·79, silica 3·00, and the amount of oxygen contained in the

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bases disposable for carbonic acid 24·25 in a hundred parts of the ash.

The ash of the leaf-stalks, accordingly, is to be considered as normal sap-ash, whose soluble constituents are augmented by 15 per cent of chloride of potassium, and the same amount of sulphate of potassa, while 30 per cent of carbonate of lime have been added to the insoluble matter. The percentage-composition of the ash of the leaves may be obtained, by deducting 10 per cent of carbonate of lime from the insoluble portion of the ash of the leaf-stalks, and adding to the soluble part 60 per cent of sulphate of potassa. The composition of the insoluble part of the ash of the leaf-stalks may be arrived at, by deducting 50 per cent of carbonate of lime from the insoluble constituents of the normal sap-ash; that of the soluble part by the addition of 15 per cent of chloride of potassium, 25 per cent of phosphate, and 15 per cent of sulphate of potassa.—By adding 20 per cent of carbonate of lime to the insoluble portion, and 20 per cent of carbonate of potassa to the soluble constituents of the ash of the leaf-stalks, we arrive at the composition of the ash of the ripe fruit, or rather at the mean composition of the ashes of the perisperm and of the capsule(1). The 20 per cent of carbonate of lime belong exclusively to the green capsule; on the other hand, the soluble ash of the perisperm differs from that of the exterior capsule, by containing 10 per cent less of chloride of potassium, and by the total amount of phosphate of potassa.

For the numerous other details, we refer to this highly valuable investigation itself which occupies upwards of a hundred octavo-pages.

Vine.—Wittstein(2) has analysed the ash of the green leaves of *Vitis hederacea*, No. 44 *b*.

Several researches have been made regarding the vine and its cultivation. In the first place, Crasso(3) has continued his investigation with the view of solving the question, how far the difference in the quality of wines (in bouquet and taste), due to the nature of the soil and the variety of the plant, may be traced in the mineral constituents contained in the must. The analyses of the following parts of the vine were made according to the method of Will and

(1) The perisperm and capsule of the fruit, being possibly of very different weight, the conclusion drawn from the above arithmetical mean is based upon a very insecure foundation.

(2) Repert. Pharm. [2] XLVI, 329.

(3) Ann. Ch. Pharm. LXII, 59. Comp. the former paper, Ann. Ch. Pharm. LVII, 69.

Fresenius, the determination of the phosphoric acid being effected by means of sulphate of magnesia, and the incineration performed in a platinum dish over a spirit-lamp supplied with a double air-current. Vine.

No. 45. Must of the unripe blue grapes of the small Burgundy (*Kleinburgunder*), or black *Claevner* (Metzger) cultivated at the south side of a porphyry declivity. The berries were soft, translucent, but still perfectly green in the interior, and only of a light-red on the side exposed to the sun.—No. 46. Must of ripe blue grapes of the same kind, from the same locality; berries uniformly deep-blue.—No. 47. Must of ripe blue grapes of the small Burgundy cultivated on the south side of a declivity, in heavy, marly, clay-soil; the colour of the berries was lighter than that of the foregoing, especially on the shaded side.—No. 48. Must of ripe green grapes, called *Schönfeilner* or *gruener Sylvaner* (Babo and Metzger). Station and soil the same as No. 45. The latter belonging to the better kinds. The berries green even when perfectly ripe.—The other properties of these four kinds of must we give in the following table.

No. in the table.	Time of gathering, 1845.	Spec. grav. of the must.	Carbonate of potassa required to saturate 100 parts of must.
45	13. September.	1·060	1·520
46	22. October.	1·085	1·055
47	28. „	1·080	1·250
48	22. „	1·065	1·110

No. 49. Blue cuticles which remain after pressing the small Burgundy of No. 45.—No. 50. Green cuticles of the *Schönfeilner* obtained in a similar manner from No. 48.—No. 51. Seeds of the small Burgundy obtained from No. 45.—No. 52. Seeds of the *Schönfeilner* from No. 48.—No. 53. Wood of the small Burgundy cultivated upon disintegrated marl.

In general the results of Crasso's analyses demonstrate, that the differences in the mineral constituents of the sap are influenced as much by the species of vine as by the station; they farther point out, that with maturity the quantity of mineral constituents is augmented, chiefly the alkali and phosphoric acid, and confirm, moreover, for the vine, the same conclusion which Wolff arrived at for the horse-chestnut, namely, that lime prevails in the wood while potassa predominates chiefly in the fruit.

The vine and grapes from the neighbourhood of Heilbronn have been investigated by Walz(1), who arrived at results perfectly analo-

(1) Jahrb. Pr. Pharm. XV, 65. For former analyses of the ash of the vine, comp. Jahrb. Pr. Pharm. XIII, 93.

Vine.

gous to those of Crasso, but far less perspicuous and definite. The analyses adduced under No. 54 to 56 have reference to the following varieties :—No. 54. *Claevner* vine with the leaves.—No. 55. *Riesling* vine with the leaves.—No. 56. *Drollinger* vine with the leaves.

Even this designation is exceedingly indefinite. Was it an entire plant that was incinerated in every case? Or how much wood, bark, and leaves, was each time employed? The incineration was effected "according to the known method" (which?).

If possible, still less circumspection is shown in the analysis of several vineyard-soils belonging partly to the ceuper-formation. Of course no mention whatever is made of a previous mechanical separation of the disintegrated constituents of the soils from the undecomposed rocky matter, nor were the soils exhausted by the various solvents. The author gives no quarter, he ruthlessly reduces his specimens to "a fine powder," in which state they become a prey to the reagents! The results obtained in such an analysis the author considers as expressing the composition of a whole field! A pebble more or less, a flint dropt by a peasant, in the specimen subjected to analysis, and the silica of the Heilbronn vineyards becomes double or treble. The course of the analysis not being detailed, we must leave it to the author to explain the enigmatical amount of 8 per cent of free alumina, together with silicate of alumina, 8 per cent of alkalies, &c. We pass over such valueless results; nor shall we for similar reasons give the analysis of 6 varieties of must. We only remark that in the latter the mineral constituents and the organic principles are determined with equal accuracy; the methods, however, are not given, which certainly is to be regretted, for we might have learned how to determine not only tartaric, racemic, malic, and citric acids, but also sugar, gum, and tannin, to the accuracy of 0·001. Even imperfectly known substances, such as "gluten" and "colouring matter" have been determined by Walz, the latter with the remarkable accuracy of 0·008 per cent of the whole solid matter!

A somewhat similar analysis of must, (Grumbacher 1846, Riesling,) has been published by L. Beltz, likewise without stating the method followed(1). The spec. grav. of the must was 1·08, and it contained 1764·32 grains of solid matter in a quart: namely, 1680·0 grape-sugar, 7·72 tartaric acid, 18·50 bitartrate of potassa, 50·50 gluten, 3·00 alumina, 2·00 lime, 2·60.—The phosphoric acid, &c., appears to have been forgotten.

(1) Jahrb. Pr. Pharm. XIV, 327.

Flax-Stalks.—Kane(1) has contributed a highly valuable continuation of his experiments upon the cultivation of flax, in which he has endeavoured to determine, by the analysis of the mineral constituents, the influence exerted on its quality both by the soil and by the water used for steeping. He was indebted, for the materials of his investigation, to Mr. Marshall, of Leeds. The stalks were cut into small pieces, carbonized in a Hessian-crucible, and without exhausting the carbon, incinerated in a platinum dish. Flax-stalks.

The course pursued in this analysis was the following: separation of the ash by dilute hydrochloric acid into residue and acid solution; separation of the residue by means of potassa-solution into silica on the one hand, and charcoal and sand on the other; division of the acid solution into three parts; 1. for the determination of the alkalies; 2. of phosphoric acid, manganese, alumina, lime, and magnesia: 3. of sesquioxide of iron and sulphuric acid. The phosphoric acid was determined according to the process of Will. In the analysis of the soils the fine earthy portion was separated from the sand by careful levigation; the amount of the latter having been ascertained, the former was dried, and the organic matter destroyed by ignition, the residue being analysed according to the method which had been used in the examination of the ash.

In the case of the waters, the residue obtained on evaporation of 2 gallons (with No. 3 only 1 gallon) of water carefully filtered was dried at 100° and weighed. It was then incinerated, and by the difference of weight the quantity of organic matter ascertained. The residue left after ignition was separated, by treatment with distilled water, into a soluble and insoluble portion, which were analysed separately.

We proceed first to the description of the several flaxes which have been analysed.

No. 24. Coarse flax, cultivated upon the soil No. 4, sown as late as the 15th of May. Amount of nitrogen in the stalks dried at 100° = 0·982 per cent.—No. 25. From the same soil. Quality excellent. Nitrogen in the stalks = 0·756 per cent.—No. 26. From the same soil. Very fine, best specimen of the year's growth. Nitrogen in the stalks = 0·876 per cent.—No. 27. From the same soil. Quality tolerably fine: sown on the 2nd May, gathered on the 29th July. Nitrogen of the stalks = 0·901 per cent.—No. 28. Dutch soil, No. 5. Nitrogen of the stalks = 1·00 per cent.—No. 29. Dublin flax. Nitrogen of the stalks = 0·56 per cent.—No. 30. Cultivated near

(1) Phil. Mag. [3] XXXI, 36 and 105; J. Pr. Chem. XLI, 434. The former paper J. Pr. Chem. XXXII, 354.

Flax-stalks.

Dublin. Another good specimen from Armagh. Nitrogen of the stalks = 0·627 per cent.

By comparing the ashes of the foregoing specimens of flax (see table) it will be at once perceived, that the amount of sulphuric acid stands in the inverse proportion to the carbonic acid (organic acids in the plant); farther, that the ash of the Irish flax contains from 21 to 25 per cent of silicic acid, instead of from 3 to 5 per cent, which is the proportion found in the other varieties. A definite replacement of silicic acid by another body cannot however be traced. The ash of Armagh flax exhibits a still greater difference from the other specimens by the enormous amount of sesquioxide of iron (13·52 per cent), which is probably the highest proportion that has hitherto been observed. Notwithstanding this extraordinary difference, the saturating capacity of the ash for organic acids is the same, that of the Belgian and Dutch specimens being expressed by 13·28, whilst that of the Irish is represented by 13·53 per cent of oxygen. The author justly alludes to the very large amount of phosphoric acid universally contained, not in the fibres, but in the refuse separated by dressing the flax, and which might be again restored to the soil.

The soils subjected to investigation chiefly belonged to the light sandy loam, only a few were purely sandy. They were excessively loose and porous, and rich in nitrogenous organic substances; they all imparted to boiling water a deep brown colour, a small quantity of alkaline and earthy salts being dissolved.

Constituents.	Localities of the different soils (each soil dried at 100°).					
	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.
	Heerstert, near Courtray	Escamaffles, best flax-land of the district of Courtray.	Hamme Zog, best flax-land of the district of Antwerp.	A district yielding only thin crops of coarse flax.	A good flax district in Holland.	Crowle, in Lincolnshire; so-called "Warp."
Potassa	0·160	0·123	0·068	0·151	0·583	0·534
Soda	0·298	0·146	0·110	0·206	0·306	0·083
Sesquioxide of iron	3·298	1·663	1·202	1·543	6·047	4·500
„ „ manganese	trace	trace	trace	—	trace	decided trace
Alumina	2·102	1·383	1·125	0·988	5·626	3·065
Lime	0·357	0·227	0·481	0·366	3·043	5·538
Magnesia	0·202	0·153	0·140	0·142	0·105	0·052
Sulphuric acid	0·025	0·017	0·013	0·026	0·023	0·113
Phosphoric acid	0·121	0·152	0·064	0·193	0·159	0·222
Chloride of sodium	0·017	0·030	0·067	0·009	0·023	0·067
Clay	14·920	9·280	5·760	4·400	17·080	—
Sand	75·080	84·065	86·797	88·385	60·947	80·702
Organic matter, remainder of the moisture	3·123	2·361	4·209	3·672	5·841	5·328
Loss	0·297	0·400	0·025	—	0·217	—
	100·000	100·000	100·000	100·081	100·000	100·204

Flax-stalks.

The substance called "*Warp*" No. 6, is the deposit which is found in the River Humber, the gradual silting-up of which has formed the muddy soil of the flax-land of the west coast; the sample analysed had not yielded a crop.—From the results of his experiments, Kane draws the conclusion that the fertility of the celebrated Belgian flax-land, *i. e.* its remarkable sponginess, as well as its richness in alkalies, phosphoric acid and magnesia, is the result of careful manuring with animal excrements, a mode of procedure which requires only a light sandy soil, with a proportion of loam just sufficient to make it coherent.

Lastly follow the analyses of some of the waters employed in the steep-pools: No. 1. was obtained from a large pond (disused turf-pit) supplied by the Scheld; the water being perfectly transparent after removal of the matter held in suspension.—No. 2. From one of the best steep-pools at Hamme Zog in Belgium, likewise supplied by the Scheld; after remaining six or eight weeks in the pool. The coating of vegetation which forms at the beginning is removed previously to commencing the process of steeping; the workmen then shovel up the mud from the bottom, and employ it for retaining the flax beneath the surface. The specimen of water taken at this period for analysis was extremely muddy.—No. 3. Perfectly transparent water of a similar pond in another part of the country.—No. 4. Perfectly clear water of the River Lys in France, collected previously to its entering the steep-pool.—No. 5. The water of a steep-pool in Holland.

Constituents.	100 parts of the residue of evaporation gave:				
	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
Sesquioxide of iron	0·514	6·633	2·584	6·200	1·183
Magnesia	0·856	1·369	1·530	1·192	7·601
Lime	6·940	8·435	17·829	5·484	3·613
Soda	28·620	11·607	30·232	28·298	19·277
Potassa	8·740	4·181	15·762	5·405	8·205
Sulphuric acid	8·054	8·435	11·627	9·300	5·607
Hydrochloric acid	25·765	8·682	2·580	7·754	9·439
Phosphoric acid	—	—	—	0·079	—
Carbonic acid, organic matter, and loss	20·511	50·658	17·856	36·288	45·075
	100·000	100·000	100·000	100·000	100·000
Residue obtained on evaporation of 100,000 parts of water	51·70	139·69	50·68	45·11	42·40

From these data the author does not venture to draw any definite

Flax-stalks.

conclusion relative to the influence of the water, and especially of the large amount of potassa existing in all, and of the enormous quantity of iron which is found in some of these specimens; such conclusions, he thinks, will be impossible until additional investigations have been performed.

At the commencement of this chapter upon the mineral constituents of plants we have pointed out, that the researches of several chemists engaged with this branch of phyto-chemistry, begin to furnish the materials for a history of the development of plants.

Investigation of Oats.—A very valuable contribution towards the elaboration of this subject has been published by J. P. Norton(1), in a comprehensive investigation of oats in the various stages of growth. He undertook to determine, both by qualitative and quantitative experiments, the variations and changes which occur in the amount of water and of mineral constituents contained in the individual organs of the plant during the period of its growth. Accordingly the investigation is divided into two separate parts: firstly, the examination of the plant during its development, and secondly, that of the ripened oats.

We give in the first place a synopsis of the quantitative part of the experiments which commence with the examination of young plants from 4 to 6 inches high, each consisting of a single leaf and the germ of the stalk; the specimens were gathered on the 4th of June, 1845. They were first desiccated at 100°, and subsequently incinerated in a platinum dish at the most gentle red-heat.

Time of gathering.	Amount of water.	Quantity of ash in plants.		Time of gathering.	Amount of water.	Quantity of ash in plants.	
		in the fresh	in the dry			in the fresh	in the dry
Leaves.				Leaves.			
4. June . .	80·51	2·16	10·83	23. July . .	77·61	3·85	16·45
11. „ . .	82·76	1·86	10·79	30. „ . .	77·00	3·78	16·44
18. „ . .	82·02	1·63	9·07	6. August .	76·63	3·75	16·05
25. „ . .	78·53	2·35	10·95	13. „ . .	74·06	6·14	20·47
2. July . .	80·26	2·24	11·35	20. „ . .	79·93	4·25	21·14
9. „ . .	76·97	2·81	12·20	27. „ . .	70·68	6·49	22·13
16. „ . .	76·53	3·06	12·61	3. Sept. .	24·60	15·78	20·90

(1) Sill. Am. J. [2] III, 100, 318.

Investigation of oats.

Time of gathering.	Amount of water.	Quantity of ash in plants: in the fresh	Quantity of ash in plants: in the dry
Stalks.			
4. June . .	87·04	1·36	10·49
11. „ . .	87·05	1·28	9·88
18. „ . .	87·13	1·28	9·32
25. „ . .	84·74	1·40	9·17
2. July . .	83·66	1·28	7·83
9. „ . .	82·05	1·40	7·80
16. „ . .	80·85	1·52	7·94
23. „ . .	79·60	1·63	7·99
30. „ . .	76·64	1·74	7·45
6. August .	75·66	2·01	7·63
13. „ . .	69·80	2·00	6·62
20. „ . .	76·27	1·58	6·66
27. „ . .	71·75	2·19	7·71
3. Sept. . .	71·70	2·36	8·35
Joints of the stalks.			
23. July . .	76·05	2·40	10·02
30. „ . .	75·54	2·54	9·60
6. August .	74·82	2·63	10·44
13. „ . .	75·29	2·80	10·48
20. „ . .	75·38	2·90	11·79
27. „ . .	73·55	2·98	11·27
3. Sept. . .	70·65	3·14	10·70

Time of gathering.	Amount of water.	Quantity of ash in plants: in the fresh	Quantity of ash in plants: in the dry
Chaff.			
16. July . .	55·01	2·72	6·00
23. „ . .	56·95	3·92	9·11
30. „ . .	50·49	6·08	12·28
6. August .	45·04	7·83	13·75
13. „ . .	40·86	11·05	18·68
20. „ . .	47·08	11·20	21·07
27. „ . .	40·44	13·38	22·46
3. Sept. .	21·96	21·43	27·47
Grain (unthrashed).			
2. July . .	80·84	0·94	4·91
9. „ . .	75·56	1·02	4·36
16. „ . .	69·83	1·17	3·38
23. „ . .	63·22	1·33	3·62
30. „ . .	62·06	1·60	4·22
6. August .	62·44	1·62	4·31
13. „ . .	55·11	1·87	4·07
20. „ . .	49·76	1·83	3·64
27. „ . .	45·92	1·90	3·51
3. Sept. .	30·74	2·53	3·65

The amount of water is largest in the leaves and stalks, but little being contained in the joints, and still less in the chaff and grain; it diminishes in all parts with the progress of maturation.

The amount of ash is greatest in the chaff, less being found in the leaves, joints, and stalks, and least in the grain; it increases in all parts with the progress of ripening, except in the (unthrashed) grain, in which it diminishes only apparently; for this diminution is due to the development of the seed, poor in ash, preponderating over the chaff which contains a large quantity of ash.

The mineral constituents of the same parts of the plant in various stages of development offer several interesting points (No. 57 to 75 inclusive). In the first place we observe with the progress of maturation in all parts of the oat a remarkable diminution of the chlorine (chloride of sodium) which altogether disappears in the leaves. In the latter a simultaneous and steady diminution of the amount of alkali to one half takes place; whilst, on the contrary, the sum of the alkalies contained in the stalks remains unaltered, the proportion of potassa and soda increasing, as the amount of chloride of sodium diminishes.—As the

Investigation of oats.

maturation proceeds the increase of silicic acid in the leaves and stalks is very considerable, in the former it is more than treble, in the latter more than double the original amount, while the phosphoric acid is observed to decrease in moderate quantities which exhibit moreover a great variation.(1) The least amount of change is perceptible in the grain, as the chaff and the seed of this compound organ compensate each other during their development.—The amount of nitrogen likewise gradually increases with the growth of the plant; 100 parts of the dried plant gathered on :

	16. July.	30. July.	13. Aug.	20. Aug.	27. Aug.	3. Sept.	Quite ripe.
gave :	1·71	1·35	1·38	1·31	1·79	2·20	2·18 per cent.

Ripe Oats.—The investigation of the straw has yielded the following data for 100 parts of the dry substance :

	Hopeton oats.		Dun oats.	Potato oats.	Sandy oats.	Healthy straw.	Smutted straw.
	Northumberland.	Kilwhiss.	Swanston, Edinb.	Northumberland.	Kilwhiss.		
Water	11·21	10·11	9·36	10·99	9·19	—	—
Ash in the top part of the straw.	4·95	5·44	8·25	9·23	10·01	5·64	6·52
„ „ middle part of the straw.	6·11	4·23	6·53	7·41	9·01	7·89	6·10
„ „ bottom part of the straw.	5·33	5·86	7·10	9·76	7·30	9·17	7·78

Hence the amount of ash does not regularly decrease from the lower to the upper parts, and is very variable at the same height in different specimens; this remark applies also to the qualitative composition of the straw as exhibited in No. 76, 77 and 78 of the table. The difference of the soil, as was to be expected, likewise occasions discrepancies. Thus two kinds of straw, No. 1. from a better kind of sandy loam soil; No. 2. from a very poor soil on which it grew badly, yielded ashes of the following composition :

	Top straw.		Middle straw.		Bottom straw.	
	No. 1.	No. 2.	No. 1.	No. 2.	No. 1.	No. 2.
Salts soluble in water	41·96	71·70	55·22	84·03	77·46	90·26
Phosphates of lime, of iron, and of magnesia	2·94	0·77	5·03	1·51	0·78	2·21
Lime and magnesia .	11·29	14·34	9·70	8·73	9·16	2·65
Silicic acid	43·75	13·18	32·05	5·72	12·55	4·86
	99·94	99·99	100·00	99·99	99·95	99·98

(1) We here call attention to the entirely relative character of the numbers on which the above data are based. Thus we cannot, f, i., clearly see whether the diminution of a constituent be actual, or whether it be only the reflex of the proportionate increase of another body.

Ripe oats.

The amount of ash in the leaves is greater than that of the straw; it exhibits the same discrepancies in its composition. The following percentage-data have been obtained:

	Hopeton oats.		Dun oats.	Sandy oats.	Potato oats.		Mean.
	No. 1.	No. 2.			No. 1.	No. 2.	
Water	9·08	9·57	10·11	10·95	10·33	11·02	10·14
Ash (of the dried leaves) .	7·19	8·44	10·29	14·79	14·59	20·90	12·70

The potato oats (5th and 6th column) had been cultivated on a poor soil, the Hopeton oats (1st and 2nd column) on a loamy soil.—The variations in the qualitative constitution become evident by comparing No. 79 with the following synopsis of the composition of the ash:

	Hopeton oats.		Sandy oats.	Top of the leaf.	Bottom of the leaf.
	Light loam.	New moss land.	Gravelly loam.		
Salts soluble in water . .	36·77	56·50	45·77	43·26	48·28
Phosphate of lime, of sesquioxide of iron and of magnesia	7·23	3·66	1·00	0·85	1·15
Lime and magnesia . . .	10·24	1·33	3·27	3·76	2·78
Silicic acid	45·75	38·50	49·96	52·13	47·79

The ash of the leaves consequently approaches in composition to that of the top straw; it is likewise different in the apex and base of the leaves.

The amount of ash in the chaff is greater than that of the other parts. Its percentage-composition was found to be:

	Hopeton oats.			Sandy oats.	Dun oats.	Potato oats.		Mean.
	No. 1.	No. 2.	No. 3.			No. 1.	No. 2.	
Amount of water . .	10·28	10·69	10·58	9·60	11·62	11·16	10·95	10·69
Ash of the dried chaff .	7·23	10·69	16·53	18·97	19·16	18·59	27·47	16·94

For comparison with the analysis (No. 80 of the table), the author gives the following results:

	Hopeton oats.		Potato oats, sandy soil.	Dun oats, loamy soil.
	Light barley land.	Light moss land.		
Soluble salts	35·02	34·12	19·86	18·66
Phosphate of lime, of magnesia, and of sesquioxide of iron	4·29	8·73	2·26	2·40
Lime and magnesia . . .	4·03	7·14	7·01	4·44
Silicic acid	56·65	50·01	70·86	74·50
	99·99	100·00	99·99	100·00

Ripe oats.

The investigation of the ashes of the grain and husks commences with a determination of the relative weight of both organs. The following results were obtained.

	Hopeton oats.				Potato oats.	Dun oats.	Victoria oats.	Black Tartary oats.	Sandy oats.	Mean.
	No. 1.	No. 2.	No. 3.	No. 4.						
Grain .	76·40	77·99	77·39	74·26	76·80	76·28	71·86	72·38	76·28	75·54
Husk .	23·42	22·00	22·61	25·55	23·20	23·66	28·22	27·62	23·68	24·26

The mean proportion of water contained in these parts was found in six experiments to be equal, or to vary only by about 1 per cent, 12·17 being found in the grain, and 11·47 per cent in the husk. The quantity of ash contained in 100 parts was found to be as follows:

	Hopeton oats.				Potato oats.	Dun oats.	Sandy oats.	Mean.
	Light loamy land.	Poor moss land.	Lime-sick land.	Reclaimed moss land.	Dry sandy land.	Good loam land.	Sandy loam land.	
Grain .	2·14	2·81	2·28	2·32	2·22	2·11	1·61	2·07
Husk .	6·47	5·27	6·49	7·11	6·99	8·24	8·03	6·60

In addition to the analyses of the ash of the husks (No. 81, 82, 83, 84 of the table), and of the grain-ash (No. 85, 86, 87 and 88 of the table), the author gives the following synopsis, in order to show the influence of the soils:

	Husk.				Grain.		
	Hopcton oats.		Potato oats.	Dun oats.	Sandy oats.	Hopeton oats.	
	Light sandy loam land.	Barren moor land.	Sandy land.	Good loam land.	Loam land.	Poor sandy land.	Land rich in humus.
Salts soluble in water .	22·92	33·84	23·14	19·96	68·52	70·69	72·96
Phosphate of lime, of magnesia, and of iron . .	1·84	4·62	1·10	2·49	21·60	18·63	12·42
Lime and magnesia . .	6·79	1·54	5·18	3·28	7·10	7·11	7·95
Silicic acid	68·55	60·00	70·57	74·25	2·78	3·30	2·67
	100·00	100·00	99·99	99·98	100·00	99·99	100·00
Percentage of ash in the dry plant . .					1·80	1·48	2·48

Norton has made a general analysis of the grain of ripe oats according to the old chemico-mechanical process of separating the

starch by levigation, and investigating the bran and liquids. The principal portion of the gluten is soluble; it is not coagulated by heat, and is assumed by Norton to be casein (legumin). We limit ourselves to giving merely the final results of these rather imperfect determinations. Ripe oats.

	Hopeton oats.			Potato oats.
	Northumberland.	Ayrshire.	Ayrshire.	Northumberland.
Starch	65·24	64·80	64·79	65·60
Sugar (impure)	4·51	1·58	2·09	0·80
Gum	2·10	2·41	2·12	2·28
Oil	5·44	6·97	6·41	7·38
Casein	15·76	16·26	17·72	16·29
Albumin	0·46	1·29	1·76	2·17
Gluten	2·47	1·46	1·33	1·45
Epidermis	1·18	2·39	2·84	2·28
Salts and loss	2·48	1·84	0·94	1·75
	100·00	100·00	100·00	100·00
Amount of nitrogen	2·19	2·35	2·28	2·76

The unusual amount of fatty oil is very surprising if it should be confirmed by others.

Sarsaparilla-Root.—The amount of ash contained in the root of sarsaparilla has been determined by Schleiden and H. Ludwig(1). The former found: 1. The best Honduras sarsaparilla to yield 5·10 per cent; 2. Unusually thick Honduras 1·94; 3. A kind of Honduras sold under the term "Caraccas" 2·36; 4. Best Caraccas 5·07, and Tampico sarsaparilla 3·92 per cent of ash.

The ash of No. 3, containing 54·71 per cent of soluble and 45·288 of insoluble matter, has been investigated by Ludwig, (No. 89).

Mulberry-Tree.—Thornton J. Herapath(2) has published an investigation of the ash-constituents of the mulberry-tree, with special reference to their distribution in the various organs. The fresh parts of the plant were bruised and exhausted by successive treatment with cold and hot water, and finally with acetic acid; the residue constitutes the "woody matter." The latter is digested with strong nitric acid, washed, and macerated with a dilute solution of potassa; this triple treatment is repeated several times, and the residue finally boiled with hydrochloric acid and again washed, when "pure

(1) Arch. Pharm. [2] LII, 61. (2) Chem. Soc. Qu. J. I, 103.

Mulberry-tree.

cellulose" remains behind. The latter when deducted from the woody substance, gives as difference the "*matière incrustante.*" The author applies the term sap to the total amount of soluble matter contained in all the washings and extracts. He gives in the first place a table of the distribution of the three substances in 1000 parts:

	Fresh organs.			Dried organs.		
	Berries.	Leaves.	Twigs.	Berries.	Leaves.	Twigs.
Cellulose (dry) . .	5·10	33·3	101·4	68·4	336·1	203·2
Matière incrustante .	13·60	65·1	309·7	182·0	266·0	620·8
Sap	55·98	146·5	88·0	749·6	598·0	176·0
Woody matter . .	18·70	98·4	411·1	250·4	402·0	824·0

The following table shows the amount of ash contained in 100 parts of the separate organs:

	Berries.	Leaves.	Twigs.
In all the organs together . . .	9·27	10·20	2·61
In the sap	11·28	12·83	5·83
In the cellulose	1·02	1·09	0·39
In the *matière incrustante* . .	4·82	7·79	2·42
In the woody matter	3·78	6·11	1·92

By these remarks the analyses of the ashes (No. 90 to 101) become intelligible.

Fossil Wood.—G. Reich(1) has published an analysis of the ash of fossil-wood and of fossil fir-cones, of the formation in which amber occurs, without, however, stating the method employed (No. 141 and 142 of the table).

Spirogyra Quinina.—W. von der Marck(2) has investigated Spirogyra quinina (Kützing). The adhering sand and infusoria could not be entirely separated by washing; when dried in this condition 100 parts of this alga gave 2·48 of dry substance, containing 7·5 per cent of nitrogen, and yielding on incineration 0·28 of ash; the method of incinerating, however, is not mentioned. This ash was found to consist of 35·8 per cent of carbonates, and sulphates of the alkalies, and chloride of sodium, 1·5 per cent of carbonate of lime, 9·3 per cent of carbonate of magnesia, 18·4 per cent of phosphate of lime, 3·4 per cent of phosphate of magnesia,

(1) Arch. Pharm. [2] LIV, 158 (2) Arch. Pharm. [2] LI, 156.

traces of sesquioxide of iron, and lastly, 31·6 per cent of silicic acid. Amount of alumina in ashes.

The "Annalen der Chemie und Pharmacie" contain a synopsis, without text or farther information, of the analysis of the ashes of various plants and parts of plants, by Thomas Richardson(1) (No. 102 to 139 inclusive).

Amount of Alumina in Ashes.—The presence of alumina in the ashes of plants is still a subject of controversy. At an earlier period Berzelius had pointed out the presence of alumina in the ashes of *Lycopodium complanatum* and *Helleborus niger*. The more recent experiments of the Prince of Salm-Horstmar appear(2) to confirm this observation; in the former he found 38·5 per cent (of the ash), in the latter a determinable quantity of alumina; in *Juniperus communis* and *Erica vulgaris* scarcely weighable traces were observed, while in the needles of *Pinus sylvestris* it was entirely absent. Salm-Horstmar seeks the cause of the different capabilities exhibited by plants of absorbing this substance, in the acid reaction of the roots of *Lycopodium complanatum*, which is not to be found in *Juniperus communis*. Salm-Horstmar has, however, omitted to give any proof that the plants under investigation were entirely freed from mechanically adhering earthy matter, which is the more to be regretted, as Knop(3) had previously proved that the alumina of the lichen-ash was derived entirely from this source. The same objection we have to make against Wittstein(4), who finds alumina in almost all garden-shrubs, *Berberis* and *Prunus* excepted. —Erdmann(5) has obtained different results; in various woods and clean seeds, in which the possibility of contamination was excluded altogether, he did not detect a trace of alumina. Hence it remains very doubtful whether the amount of alumina contained in the ash-analyses of the table actually belong to the plants or not.

Proportion of Ash in various Woods.—Chevandier(6) has communicated the following as the mean results of a great number of

(1) Ann. Ch. Pharm. LXVII, Appendix to Heft 3.
(2) J. Pr. Chem. XL, 302; Chem. Gaz. 1847, 306.
(3) J. Pr. Chem. XXXVIII, 347.
(4) Repert. Pharm. [2] XLIV, 322; J. Pr. Chem. XL, 254.
(5) J. Pr. Chem. XL, 254.
(6) Compt. Rend. XXIV, 269. A report of De Candolle, on this and the earlier (published since 1844) investigations of Chevandier upon the composition of various kinds of wood, is to be found in Arch. Ph. Nat. VIII, 5. We borrow from this report the following synopsis of the composition of various kinds of dried wood, in which the

Proportion of ash in various woods.

determinations of the average amount of ash contained in various kinds of wood (dried at 140°) :

Ash given by 100 parts of wood.	
Willow	2·00
Aspen	1·73
Oak	1·65
Hornbean	1·62
Alder	1·38
Red beech	1·06
Pine	1·04
Fir	1·02
Birch	0·85

Average amount of ash given by all kinds of wood.	
100 Wood from young stems	1·23
„ Stack-wood	1·34
„ Branches	1·54
„ Twigs	2·27

Food. Cooking of Meat. Flesh Extract.—The investigation of Liebig(1) into "the constituents of the juices of flesh," also furnishes some results belonging to the technical department of chemistry, in so far as it treats of the changes which cooking effects in meat, and of the relation which animal food bears to analogous dietetic articles, determining, as it does, at the same time, experimentally the nature of "broth."

The view that broth derives its nourishing properties essentially from the dissolved gelatin—an opinion which has been frequently discountenanced in practice—is shown by this investigation to be completely untenable. The gelatin imparts no taste to broth, and forms by far too insignificant a portion to allow of its nutritious properties being dependent upon it. Chopped beef, or veal, previously exhausted in the cold, when boiled for five hours, yielded to the broth, the former ½ per cent, and the latter 1½ per cent of soluble constituents, of which gelatin formed, at most, but one half.—On the

oxygen is represented as being in combination in the form of water. The column, hydrogen, gives the excess of this element over that contained in the water :

	Carbon.	Hydrogen.	Nitrogen.	Water.
Red beech	49·85	0·70	1·06	48·39
Oak	50·44	0·70	1·06	47·80
Hornbean	49·48	0·63	0·84	49·05
Birch	51·30	1·09	0·88	46·73
Aspen	50·35	0·96	0·82	47·87
Alder	51·86	1·03	1·15	45·96
Willow	51·10	0·77	0·86	47·27
Fir	51·59	0·95	1·04	46·42
Pine	51·71	0·94	0·81	46·54

(1) Loc. cit. II. p. 161.

contrary, this investigation confirms the view of Proust, that the peculiar constituents of broth exist ready formed in the flesh, and are by no means merely products of the process of ebullition. The residue of the chopped muscular flesh of different animals—as of the fox and ox—after having been exhausted in the cold, cannot be distinguished the one from the other; all the peculiarities of the flesh, especially its flavour, depending entirely upon the soluble constituents which are found in the broth.

The researches of Liebig offer a simple and convenient method of preparing, in a few minutes, a broth of the highest nutritive properties. Finely chopped lean beef is mixed with an equal weight of cold water, and left, if possible, to macerate for a short time, and the whole then slowly heated to ebullition. After gently boiling for some minutes, the clear broth separates from the coagulated albumin, and from the muscular fibre which has now assumed a sinewy appearance. After straining, it requires only to be seasoned, and slightly coloured with burnt onions, or with caramel. The colouring of the broth is nothing but a concession to the common prejudice, which cannot, however, be well dispensed with.

By evaporation in a water-bath, or at a still lower temperature, the broth becomes spontaneously coloured, and leaves behind a brown extract, possessing a delicate odour of roasted meat; it may be preserved for any length of time. This extract, when dissolved in about 30 parts of water, and flavoured with salt, yields, at any moment, a most excellent broth.—The advantage of extract of flesh for the nutrition of invalids, its use in hospitals, or in field-service, as well as in domestic economy, is sufficiently obvious. We see, likewise, that bone-broth, broth-tablets, &c., being preparations essentially different from a true broth from flesh, cannot enter into competition with it as articles of food.

As an article of commerce, extract of flesh bears somewhat too high a price; it appears, however, to offer a new source of profit to the inhabitants of the different settlements in America and Australia, who might successfully prepare it from their cattle at a cheaper rate, and send it to the markets of our crowded populations.

As to the cooking of meat, it follows, that to prepare, by boiling, a rich broth, and at the same time a savoury *bouilli*, is perfectly impossible. After preparing broth according to the above direction, the meat which remains is perfectly unpalatable, tasteless, and tough, and as dissimilar as possible to the boiled beef of our tables.—If, on the other hand, it be desired to leave in the boiled meat the greatest possible amount of nutrition and flavour, it must be at once

Food. Cooking of meat. Flesh extract.

plunged into boiling water. If the temperature, after some minutes, be reduced to about 70°, by the addition of cold water, and the water maintained at that temperature until the meat is thoroughly cooked, all the conditions necessary for this purpose will have been fulfilled.

If it be perfectly established that pure fleshy fibre—viewed independently of the constituents of the juice—instead of being softened by boiling, is converted into a horny, or sinewy mass, it is evident that this change is prevented by two different means in the ordinary mode of cooking meat: in the first place, by the temperature in the interior of the piece of meat never reaching the boiling heat, and in the second place, by its being, nevertheless, sufficiently high to coagulate the albumin which surrounds, and to a certain extent protects the fibres. The temperature in the interior of the meat, is not only sufficient to coagulate the albumin (55°·6), but must attain even the point necessary for the coagulation of the colouring matter of the blood (from 65° to 70°).

The investigation of Liebig exhibits the process of salting meat, under a perfectly new aspect. The "brine," which meat and dry salt form when together, amounts to from $\frac{1}{3}$ to $\frac{1}{2}$ of the juice of the meat, and contains the chief constituents of concentrated broth. The brine presents an acid reaction, and, owing to the quantity of albumin present, coagulates when boiled; it contains, moreover, phosphoric acid, lactic acid, a large amount of potassa, creatinine, and doubtlessly also creatin. There can be no doubt, therefore, that salting diminishes the nutritious properties of meat, by the amount of constituents which pass into the brine; hence the explanation of the well-known injurious effect on health produced by the continued consumption of salt-meat.

Influence of Salt upon the Feeding of Cattle.—Boussingault(1) has extended his earlier observations upon the influence of salt as an adjunct to the fodder of cattle, by some valuable contributions. His earlier experiments had shown, that salt by no means exercises a beneficial influence upon the growth of cattle, and upon the development of flesh, to the extent usually ascribed to it. The new series of experiments, extending over a period of 13 months, was made with a number of steers, some of which had their rations salted, while the others had no salt mixed with their food; they were, in other respects, treated in a perfectly similar manner. The following are the final results obtained:

(1) Ann. Ch. Phys. [3] XX, 113; XXII, 116, 503; Compt. Rend. XXV, 729; Dingl. Pol. J. CVII, 304; J. Pr. Chem. XL, 168; XLIII, 383; XLV, 127.

Original weight.	Weight after 13 months.	Increase of weight in 13 months.	Consumed hay.	Increase of weight produced by 100 kilogr. of hay.	Influence of salt upon the feeding of cattle.
434 kilogr.	950 kilogr.	516 kilogr.	7178 kilogr.	7·19 kilogr. (those with salt).	
407 „	855 „	452 „	6615 „	6·83 „ (those without salt).	

On the average the former number received 18·2 kilogr. of hay daily, and increased therewith 1·309 kilogr. in weight; the same amount of hay corresponds, in the others, to a development of flesh amounting to 1·243 kilogr. The value of the increase, namely, 66 grm., did not compensate for the cost of the salt, of which were consumed 102 grm. "Although," Boussingault farther remarks, "the salt exercises no considerable influence upon the growth, yet it appears to exert a beneficial effect upon the appearance and the condition of the animals." The steers that were deprived of salt for 11 months, appeared sluggish and of languid temperament; their coats were rough, devoid of gloss, and partially bare. Those which had been fed with salt were lively, had a fine glossy coat, and were sure to obtain a considerably higher price at market.

Difference between Dry and Moistened Fodder.—Under the direction of Boussingault, E. Oppermann(1) has tested by experiment the widely diffused view of the practical farmer, that soaked fodder forms a more suitable food than that which is dry. In each experiment two heifers, from 17 to 19 months old, were supplied for a period of 14 days with rations, in the proportion of 3 kilogr. to 100 kilogr. of their weight; those under No. I. being fed with soaked hay, and those under No. II. with dry hay. The heifers under No. I. were found to have increased, on the average, about 23 kilogr., and those under No. II. about 20 kilogr., a result which appears in favour of moistened fodder, although, according to the opinion of Boussingault, the increase does not compensate for the additional trouble. By reversing the order of feeding, the results were found to be essentially the same; the moistening of the fodder appeared to have no influence upon the secretion of milk. The use of moistened fodder is of advantage only in cases in which quick fattening is required, since the cattle devour the fodder much quicker—nearly 12 times as fast—when it is in this condition.

Adulteration of Flour.—Many chemists have been engaged in finding out a means of proving the presence of fraudulent additions to flour. In order to detect the presence of the meal of beans, or of other leguminous plants, which is often employed in France, Vil-

(1) Ann. Ch. Phys. [3] XIX, 249.

Adulteration of flour.

lain(1) recommends the preparation of a portion of gluten from the suspected flour; the gluten, if the flour has been adulterated, is characteristically distinguished from that obtained from pure flour, by its cohesion, elasticity, colour, &c.

Lassaigne(2) avails himself of a solution of sulphate of protoxide of iron, which renders an infusion of pure flour somewhat yellow, and imparts a bottle-green colour to that which is adulterated with bean-meal.—Donny(3) employs nitric acid and ammonia successively. Flour, when thus treated, exhibits nothing remarkable, but bean-meal, on the contrary, strikes a deep-red colour. According to the statements of the same author, if flour, containing bean-meal, be treated with potassa, an insoluble residue of cellulose will remain, which may be readily distinguished under the microscope, while pure flour shows nothing of the kind.

According to Filhol(4), the adulteration of flour with maize-meal may be recognized by the peculiar yellow coloration, which is produced by the action of dilute potassa.—According to Mauviel-Lagrange(5), the suspected flour should first be treated with nitric acid, and the mixture after being diluted, saturated with carbonate of potassa; if it be pure, a precipitate of yellow flocks alone is formed, but if it be adulterated, numerous orange-yellow specks are produced in addition.

Louyet(6) has communicated a method of detecting the adulteration of flour, calculated to enable the experimenter to judge of it in a commercial view. It consists in determining the amount of ash in the flour, it having been found that wheaten flour yields, on the average, 0·8 per cent, rye-flour 1·0, bean- and pea-meal 3, linseed-cake 10 per cent of ash. The adulteration, however, is not only to be inferred from the increase of ash, but also from its quality, and especially from the circumstance of the phosphates existing as bibasic, or as tribasic salts. The insufficiency of this proposal is self-evident. The differences in the amount of ash are far too small to afford accurate means of discrimination, and Erdmann has shown,

(1) J. Chim. Méd. [3] IV, 524.

(2) J. Chim. Méd. [3] III, 633.

(3) Ann. Ch. Phys. [3] XXI, 5. Mareska has likewise described the same process, J. Pharm. [3] XII, 98.

(4) Ann. Ch. Phys. [3] XXI, 187.

(5) J. Chim. Méd. [3] IV, 339. Comp. a synopsis of the falsifications of various kinds of food, by Chevallier, J. Chim. Méd. [3] IV, 510, and of the various methods of recognizing the adulteration of flour, by Donny, Ann. Ch. Phys. [3] XXI, 5.

(6) J. Chim. Méd. [3] IV, 164; J. Pharm. [3] XIV, 355; Dingl. Pol. J. CVIII, 290; CXI, 442.

moreover, the constitution of the phosphates in an ash to be altogether accidental, dependent as it is upon the method of incineration, and not upon the nature of the substances incinerated. With regard to the numerous determinations of the amount of ash of various kinds of flour, we refer to the original.

Malt-dough as a substitute for bread.

Malt-dough as a Substitute for Bread.—Schlossberger(1) has made a trial of the "malt-dough" (*Malztaig*), or "upper-dough" (*Obertaig*) of beer-breweries, which has been recommended by Essig, of Leonberg, as a substitute for flour. By these terms is understood, as is well known, the dough-like mass which is deposited upon the grains in the process of mashing, and which is formed from the mealy portion of the malt. It contains from 75 to 78 per cent of water, from 4 to 7 per cent of starch, and from 3·9 to 4·8 per cent of nitrogen, indicating a much larger amount of gluten than is contained in flour, and a considerable quantity of phosphates. Rye-bread, prepared with an addition of malt-dough, was found to contain from 3 to 4 per cent of nitrogen, and from 50 to 52 per cent of water. This bread appeared to keep very well, and had not the slightest unpleasant taste.

Oïdium aurantiacum.—Payen(2) has made some experiments, with the view of removing the doubts raised against his discovery, that the orange-red mass which is developed in a certain decay of bread, consists of a peculiar fungus (*Oïdium aurantiacum*), originally derived from the flour. It had been urged that the spores of this fungus would have been killed by the heat employed in baking. When Payen exposed a quantity of these spores, in a glass-tube, to a heat of from 100^0 to 120^0, and then disseminated them upon bread-crumbs, the fungus was freely developed, whilst in a counter-experiment with the same bread on which no spores had been sown, no change whatever was observed.—A heat of 140^0 completely destroys the power of germinating.

Potato Disease.—The disease of potatoes has not yet been traced, with any degree of certainty, to its true cause; however, it has been the subject of much bold speculation.

G. Kemp(3) has found that the sound part of a potato yields from 4·14 to 4·25 per cent of ash, while the diseased portion gives from 5·55 to 5·78 per cent. The latter, moreover, yielded, as a

(1) Dingl. Pol. J. CIII, 318, from Riecke's Wochenblatt, 1847, 3; subsequently in Dingl. Pol. J. CIV, 375.

(2) Ann. Ch. Phys. [3] XXIV, 253; Compt. Rend. XXVII, 4.

(3) Chem. Gaz. 1847, 69 and 136.

Potato disease.

mean of three analyses, 41·93 per cent of carbon, 6·86 of hydrogen, 1·23 of nitrogen, and 44·28 of oxygen.—By a comparison of these numbers with those of an elementary analysis of the raw potato, made by Boussingault, the author, who altogether forgets the influences of different localities, of the year of growth, &c., is led to the *a priori* conclusion, that the putrefaction of potatoes gives rise to the formation of butyric acid which had been found by others, and to the inference that the potato disease consists in an abnormal tendency to premature germination. Fungi, &c., according to Kemp, are secondary phenomena.

H. Reinsch(1) entertains the view that the interior of the potato resembles an apothecary's shop, *i. e.* that each constituent of the sap is enclosed in a separate vessel, or rather cell; he defines the potato disease as the consequence of that chemical action which results when the walls of the cells become so thin as to burst; when these separated constituents come into immediate contact, the result is that kind of civil commotion which is usually called putrefaction.

Ash of Molasses.—In the ash of raw sugar, and of the molasses from the same sugar-cane, Richardson(2) found:

	Molasses.	Raw sugar.
Potassa	36·23	19·42
Lime	12·72	14·67
Magnesia	11·14	10·72
Sesquioxide of iron	2·62	6·55
Protoxide of copper	trace	0·71
„ „ manganese		trace
Chloride of potassium	1·58	8·03
„ „ sodium	25·87	15·46
Sulphuric acid	7·91	10·85
Silicic acid	1·93	13·59
Amount of ash	3·60	1·33

Sugar Refining.—J. Scoffern(3), of London, has taken out a patent for a new method of refining cane-juice. It consists in the employment of a solution of litharge in acetic acid, and precipitation of the excess of lead—after filtration—by sulphurous acid. It is doubtful if this be a real improvement of the refining process.

(1) Jahrb. Pr. Pharm. XVI, 182.
(2) Phil. Mag. [3] XXXI, 336; Dingl. Pol. J. CVI, 453; J. Pr. Chem. XLII, 319.
(3) From London Journ. of Arts, Oct. 1848, 196, in Dingl. Pol. J. CX, 261.

Wine.—Batillot, in a separate work, "*Traité sur les Vins de France,*"(1) has collected a great number of interesting accounts, and results of experience, respecting the production of wine in France. Referring as we do to the original work, we shall quote only the following details. According to the author, two colouring matters exist in red wine, *rosite* and *purprite*. Batillot states that rosite is of a rose colour, and is soluble in water and alcohol, but not in ether; it is not precipitated from its aqueous solution either by gelatin or albumin. It predominates in the sediments of the casks after the first racking off.—In like manner, according to the author, the deposit from old wines consists almost entirely of purprite, which has a blackish, dark-red colour, and an astringent taste; it is soluble in water and in ether, but not in spirits of wine; it likewise dissolves in sulphuric acid, from which it is reprecipitated by water. It forms with gelatin a precipitate which is insoluble in alcohol and in water.—The author extols tartaric acid as an excellent preservative of red wine, since it is not only an effectual preventative against many so-called diseases, but also counteracts the pernicious influence of high temperatures. Bordeaux wines are distinguished by being able to cross the line without suffering damage; the same property may be imparted to Burgundy, by addition of 1 grm. of tartaric acid to a litre of wine. Wine.

Fresenius(2) has subjected some of the best Rhenish wines, of 1846, to chemical investigation, with particular reference to their value. For this purpose he selected: 1. Hattenheimer; 2. Markobrunner; 3. Steinberger, these three being average specimens of the entire produce on the Nassau domains, in 1846; 4. Choice Steinberger (*Auslese*), placed at his disposal by the direction of the Nassau domains. All these specimens were kept perfectly pure, and had been obtained by fermentation in covered vessels. At the time of investigation, the wines were four months old, but had not been racked. No. 1, 2, and 3, were nearly bright, but No. 4. was still in a slight state of fermentation.

The alcohol was estimated from the spec. grav. of the distillate; the sugar, from the carbonic acid evolved during fermentation, the formula of anhydrous grape-sugar ($C_{12}H_{12}O_{12}$) being taken as the basis of the calculation; the free acid, by means of Will and Fresenius' acidimetrical apparatus, and lastly, the extract, by evaporation, and drying at 100°.

(1) J. Pharm. [3] XIV, 107 (in abstr.); Bull. Soc. d'Enc. 1848, 451; Dingl. Pol. J. CX, 66.

(2) Ann. Ch. Pharm. LXIII, 384; Dingl. Pol. J. CVII, 289.

Wine.

	1.	2.	3.	4.
Water	85·08	83·68	84·38	78·27
Whole amount of extract .	4·21	5·18	5·56	10·55
Anhydrous grape-sugar .	3·58	4·52	4·49	8·63
Free acid, expressed as HO $\bar{T}$	0·556	0·533	0·497	0·424
Alcohol	10·71	11·14	10·07	10·17

Accordingly, the quantity of anhydrous grape-sugar in the must of No. 1. is calculated to be = 24·52, of 2. = 26·25, of 3. = 24·12, of 4. = 28·46 per cent.—The facts derived from analysis, either individually, or collectively, do not admit of a safe conclusion regarding the quality of the wines, because the most important principle—the bouquet—does not admit of quantitative determination.

Liebig(1) points out that Rhenish wines, by long vatting, and the filling up which is thereby necessary, acquire, on the one hand, additional flavour and bouquet, but that, on the other, they have also the amount of acid increased to an extent which is even prejudicial to health. In the first instance, a deposit takes place of bitartrate of potassa which decreases in solubility by the evaporation of the wine, as well as by the continual formation of alcohol; the deposition probably taking place at the same rate as its quantity is increased by the filling up of the cask. But with the filling up, the contents of a cask receive at the same time free tartaric acid, which likewise increases, and at a certain period begins to augment again the solubility of the bitartrate of potassa; hence the large amount of acid contained in very old Rhenish wine. The removal of the acid by the ordinary alkaline agents, cannot of course be effected without injuring the quality of the wine. Liebig recommends for this purpose the employment of neutral tartrate of potassa, which may be used without the slightest detriment either to the bouquet or flavour of the wine. For a litre of old wine of 1811, 3·5 grms. were necessary; a sensible excess would, of course, produce a very injurious effect upon the flavour. We have to recollect, moreover, that the formation of the bouquet is occasioned by the acid, which consequently must never be separated previously to fermentation.(2)

Ure(3) has recently endeavoured to demonstrate the inefficiency of Liebig's method, by experiments made with the Port wines stored in the London Docks. He might have known, without performing express experiments, that the acid properties derived from

(1) Ann. Ch. Pharm. LXV, 352; Arch. Ph. Nat. VIII, 281.

(2) Dumas mentions in Vol. VI. (1843), p. 515 of his Chimie Appliquée, that this method of de-acidification has been introduced on a large scale.

(3) Pharm. J. Trans. VIII, 63; Repert. Pharm. [3] I, 216.

acetic acid, cannot be removed by means of neutral tartrate of potassa; moreover, he ought not to have forgotten that Liebig has recommended this process solely for Rhenish wines. Buchner(1) has confirmed the success of Liebig's process. Wine.

Bouchardat(2) has investigated the different kinds of grapes cultivated in Lower Burgundy. The examination of wines prepared from these grapes, yielded the following results:

	Quantity of Wine per hectare.	In the wine from 1 hectare is contained:		
		Alcohol.	Tartaric and malic acids.	Potassa.
Gouais blanc . .	240 hectolit.	7·88 hectolit.	112·4 kilogr.	15·3 kilogr.
Gros Gamay (the most inferior kind of all) .	160 „	8·18 „	67·2 „	9·44 „
Gros Verreau . .	90 „	6·28 „	36·9 „	5·13 „
Petit „ . .	60 „	4·92 „	20·4 „	3·92 „
Melon	80 „	7·28 „	24·3 „	3·92 „
Servoyen vert . .	50 „	4·40 „	17·0 „	2·35 „
„ rose . .	30 „	3·00 „	7·7 „	1·23 „
Pineau noir . . .	20 „	2·12 „	4·2 „	0·74 „
„ blanc . .	15 „	1·52 „	3·9 „	0·61 „

He has arrived at the conclusion, that situation and locality have less influence upon the quality of (Burgundy) wine, than is usually imagined, and certainly far less than is occasioned by the difference in the variety of grape.

According to the observations of Fr. Mayer(3), genuine Malaga wine, is of a dark-brown colour, but perfectly bright; it does not form either mould or deposit, even when kept in half-filled bottles for two or three weeks. Its odour, usually termed Spanish odour, is peculiarly fragrant, being associated, at least with the newer kinds, with a feebly acid smell, resembling that of caramel, and indicating that the wine is prepared from boiled must. Its taste is sweet and spirituous. Mayer has examined the special properties of seven varieties, namely, 1. wine obtained from a firm not named, and which could not warrant the accuracy of the year's growth; 2. wine of 1834, from another firm not named; 3. of 1840, from the same source; 4. of 1841, from B. Rümelin, of Heilbronn; according to information received from this merchant, the undoubted genuineness of this kind could be depended upon; 5. of 1842, and 6. of 1844, both likewise from

(1) Repert. Pharm. [3] I, 206.
(2) From Rev. Scientif. Aug. 1846, in the Jahrb. Pr. Pharm. XIV, 268.
(3) Jahrb. Pr. Pharm. XV, 201.

Wine. Rümelin; 7. from the same source as No. 1., the year of growth not being mentioned.

These wines, on investigation, yielded the following results which are arranged according to the increasing proportion of alcohol:

	Year of growth.	Spec. grav.	Alcohol. percentage vol.	Cryst. grape-sugar. percentage weight.	Extract. percentage weight.
No. 7.	unknown	1·037	12·50	9·91	14·4
No. 1.	1834	1·069	13·17	not determined	not deter.
No. 2.	1834	1·069	13·50	„	„
No. 6.	1844	1·057	14·93	„	„
No. 4.	1841	1·057	15·00	14·72	18·4
No. 5.	1842	1·056	15·34	14·51	18·7
No. 3.	1840	1·070	16·07	not determined	not deter.

The amount of alcohol was determined by distilling the wine, and the sugar by the process of fermentation, the apparatus of Fresenius and Will being employed. By comparing the spec. grav. of the unaltered wine, and that of the residue of distillation after having been mixed with water, so as to reproduce the original volume, values for the amount of alcohol were obtained varying considerably from the result of direct experiment.

On calculating the amount of sugar corresponding to the alcohol, and adding it to the quantity of sugar given in column 4, we arrive at the proportion originally contained in the must, which in No. 4. = 40·18, in No. 5. = 40·16, and in No. 7. = 38·38 per cent.

Ether, when agitated with the wine, removes its aroma, and leaves after evaporation a decidedly acid extract, which is not very volatile, and exhibits the reactions of tartaric, citric, and malic acids.

The wines investigated yielded, on addition of ammonia, a precipitate of phosphate of magnesia-ammonia; in No. 1. this precipitate amounted to 0·147, in No. 3. to 0·129, and in No. 4. to 0·139 per cent. Qualitative analysis, moreover, pointed out the presence of sulphuric acid, lime, and tannin; in one of the specimens which is not particularized, 0·38 per cent of ash was found. The solid residue, obtained by evaporating the wine to dryness, dissolved again in water, forming a perfectly bright solution.

For the farther statements upon the culture and production of Malaga wine in Spain, we refer to the very comprehensive synopsis, in the above-quoted treatise.

Separation of Fusel-oil from Brandy.—For the removal of the fusel-oil from brandy, W. Peters(1) proposes to introduce into the casks

(1) Mittheilungen des Gewerbevereins für das Königreich Hannover, Lief. 53 and 54; Dingl. Pol. J. CVIII, 79; Arch. Pharm. [2] LIII, 335.

the usual quantity of thoroughly ignited wood-charcoal, in the middle of which, however, is placed a layer of a mixture of one part of binoxide of manganese, with two of bone-black. A cask prepared in this manner, is stated to retain its efficacy for from 12 to 15 months.

Separation of fusel-oil from brandy.

Knop(1) has endeavoured to remove the fusel-oil from potato-brandy, by a process of oxidation. He precipitates a solution of sulphate of copper with caustic potassa, pours the liquid containing the hydrated protoxide into the brandy to which a small quantity of potassa has been previously added, and digests for a considerable time. Under the influence of solar heat, a portion of the protoxide is found, after the lapse of some days, to be reduced to the state of suboxide. The brandy, when drawn off, still possesses a peculiar vegetal odour, but no longer that of fusel-oil. It is doubtful, however, whether this process will supersede the methods actually in use at present.

Inorganic Constituents of English Beer.—Thos. Dickson(2) has undertaken a comprehensive analytical investigation into the inorganic constituents of British beers, for the purpose of gaining, if possible, a standard whereby to judge of their real value, as an article of diet. The results of the analyses, which were conducted according to the method of Fresenius and Will, and so calculated as to represent the dry substance, after deducting the residuary carbon, are given in the table facing Vol. II, p. 318, under No. 143 to 165. The object which the author had in view, could scarcely be accomplished by such a series of analyses, owing to the great influence exercised by the different qualities of the soils on which the barley is cultivated, and to the variations in the brewing processes by which the beers are prepared. The results obtained, nevertheless, possess great interest, filling up as they do a blank in this department of the chemistry of food. They are the more valuable, since Dickson has not merely published the examination of a single specimen, but the analysis of a whole series of beers, a mode of proceeding which cannot be over-estimated in investigations of this kind.

Removal of Copper from Vinegar.—In vinegar-manufactories, copper boilers are conveniently used for a variety of purposes; these vessels have, however, at the same time, the disadvantage of imparting copper to the vinegar. Roder(3) has made the very judicious proposal to

(1) Pharm. Centr. 1847, 687.

(2) Phil. Mag. [3] XXXIII, 341; Dingl. Pol. J.CX, 371; Froriep's Notizen. 1849, Nr. 179.

(3) From Bolley's Schweiz. Gewerbebl. in Dingl. Pol. J. CV, 79.

Fuel and Illuminating materials. Fuel.

digest the vinegar, for about a fortnight, with from 2 to 3 per cent of freshly ignited wood-charcoal. After the lapse of this period, the whole of the copper is precipitated.

Fuel and Illuminating Materials. Fuel.—W. Baer(1) has published the first of a series of investigations into different varieties of fuel. It comprehends various kinds of wood, turf, brown-coal, and coal, the results of which are given in the table facing Vol. II., p. 350. With regard to the different woods (No. 1 to 8 inclusive), it is to be regretted that the author, like some of his predecessors, has omitted to give the botanical names of the species investigated, so that we do not know whether his "oak wood" is that of *Quercus robur*, or of *Q. pedunculus*; nor do we accurately know what is to be understood by "Kienholz."

The different kinds of turf are:

No. 9. From the old royal turf-pit, near Buchfeldt and Neulangen, first quality.—No. 10. From the same place, second quality.—No. 11. From the royal turf-pit, near Flatow, first quality.—No. 12. From the new pit, near Linum, second quality.—No. 13. From the same place, third quality.—Here also we regret not to find more accurate statements regarding the properties and the age of the turf.

The varieties of brown-coal are: No. 14. Bohemian coals from Schönfeld, near Aussig.—No. 15. Coals from Plauen.

The other coals are: No. 17. Humricks coal, from Stockton, the coke of which was likewise analysed.—No. 18 and No. 16. Hawthorn Hartley coal from Newcastle, both powerfully caking.

The qualitative examination of the ashes of these fossil fuels is in some respects interesting. In the case of the two varieties of coal, (No. 17 and 18) the ashes were found to consist of lime (in minute traces; magnesia in the first variety only); sesquioxide of iron, alumina, together with sulphuric and silicic acids in very variable quantities. In the ashes of brown-coal the same constituents were found, but in addition chlorine and potassa in the first, and likewise soda in the second variety.—The ashes of the five kinds of turf contain, besides the above constituents, carbonic and phosphoric acids; in the ashes of No. 2 and 5, however, the latter was absent. By a direct experiment, it was proved that only soda, and not a trace of potassa, was present.

The determinations of water have reference to the substances

(1) Arch. Pharm. [2] LVI, 159.

COMPOSITION OF VARIOUS KINDS OF FUEL.

KIND OF FUEL.	Number.	100 parts of dry fuel							100 parts of fuel in the natural state lose at 100° C. water.	Spec. grav.	
		contain :					leave :				
		Carbon.	Hydrog.	Nitrogen.	Sulphur.	Oxygen.	Ash.	Coke.			
Birch	1	48·89	6·19	—	—	43·93	0 99	—	13·14	—	Baer.
Red beech first variety	2	46·10	5·79	—	—	46·87	1·24	—	14·4 to 13·6	—	
,, second variety	3	48·29	6·00	—	—	45·14	0·57	—	13·7	—	
White beech	4	48·08	6·12	—	—	44·93	0·87	—	12·8	—	
Oak	5	48·94	5·94	—	—	43·09	2·03	—	8·0	—	
Wild pear (service-tree)	6	48·63	5·94	—	—	44·75	0·68	—	13·7	—	
Pine young trees	7	50·62	6·27	—	—	42·58	0·53	—	12·1	—	
,, old trees	8	49·87	6·09	—	—	43·14	0·63	—	11·9	—	
Turf	9	51·54	4·69		33·90		9·87	—	15·7	—	
,,	10	50·13	5·36		35·24		9·37	—	21·7	—	
,,	11	50·36	4·20		34·27		11·17	—	18·4	—	
,,	12	53·69	4·84		31·73		9·74	—	16·4	—	
,,	13	55·01	4·63		31·44		8·92	—	18·9	—	
Brown-coal	14	61·20	5·17		21·28		12·35	—	21·2	—	
,,	15	55·59	4·16		19·06		21·19	—	11·0	—	
Coal	16	76·87	4·99		11·99		6·15	—	1·2 to 0·85	—	
,,	17	86·86	5·00		7·36		0·78	—	0·99	—	
Coke of this coal	18	93·04	0·26		1·61		5·09	—	—	—	
Coal	19	81·41	5·83	2·05	0·75	7·90	2·07	66·70	1·355	1·276	Vaux.
,,	20	80·07	5·53	2·12	1·50	8·09	2·70	60·36	0·906	1·276	
,,	21	75·80	5·21	1·92	0·90	11·89	5·17	65·50	3·232	1·279	
,,	22	78·57	5·29	1·84	0·39	12·88	10·30	57·21	11·29	1·2785	
,,	23	—	—	—	2·57	—	3·01	58·20	8·39	1·276	
,,	24	—	—	—	—	—	35·49	66·50	5·624	1·578	
,,	25	90·39	3·28	0·83	0·91	2·97	1·61	92·10	2·00	1·3925	
,,	26	66·31	5·63	0·56	2·36	22·86	2·27	30·71	34·66	1·129	
Kind of turf	27	54·02	5·21	2·30	0·56	28·17	9·73	29·30	25·56	0·8495	
Coal	28	62·00	5·00	0·92	—	17·83	14·25	56·5 to 57·6	—	—	La Cava.
,,	29	76·49	4·86	0·93	—	13·01	4·71	60·7 to 61·3	—	—	
,,	30	86·88	4·37		8·74		10·69	86·47	—	1·356	Nendtvich.
,,	31	88·30	4·80		6·90		5·82	82·82	—	1·313	
,,	32	89·69	5·03		5·27		10·33	81·55	—	1·350	
,,	33	83·76	4·97		11·26		11·415	77·81	—	1·378	
,,	34	88·76	5·04		6·20		2·91	76·82	—	1·291	
,,	35	86·72	5·09		8·19		12·05	78·57	—	1·339	
,,	36	85·29	5·05		9·65		1·605	73·11	—	1·317	
,,	37	85·48	4·92		9·59		2·395	70·96	—	1·282	
,,	38	84·54	4·96		10·50		2·615	68·17	—	1·287	
,,	39	82·54	4·35		13·10		10·53	76·33	—	1·423	
Brown-coal	40	67·49	4·70		27·80		10·99	68·70	—	1·494	
,,	41	71·55	5·19		23·25		5·66	—	—	1·359	
,,	42	67·85	4·93		27·22		9·41	61·23	—	1·403	
,,	43	71·89	4·79		23·31		4·35	59·55	—	1·347	
,,	44	70·84	4·71	—	0·91	24·44	2·39	50·89	18·68	1·285	
,,	45	72·18	5·18	—	0·55	22·63	2·08	55·98	17·00	1·300	
,,	46	72·49	5·17	—	1·30	22·33	2·255	53·00	17·82	1·289	
,,	47	71·36	5·09	—	1·63	23·54	4·645	46·00	17·10	1·334	

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"dried in the air." The analyses were effected by combustion, it is not stated with what agent. The woods were sawn diagonally into thin pieces. The sulphur and nitrogen of the coals have not been estimated.

For the results obtained by Chevandier in the analysis of different kinds of wood, we refer to Vol. II. p. 337.

We are indebted to Fred. Vaux(1) for a new and very careful investigation of British coals. He determined the sulphur by means of nitre, and carbonate of potassa, the nitrogen by the method of Will and Varrentrapp, and the carbon and hydrogen by combustion with oxide of copper and chlorate of potassa. He has investigated the following kinds, the numbers having reference to the table, facing Vol. II. p. 350: No. 19. Newcastle caking coal; of blackish-blue colour, resinous lustre, and cubic fracture; brittle, and slightly soiling the fingers, and containing here and there thin layers of iron pyrites. Its coke exhibited a semi-metallic lustre, and a coarse-grained fracture.—No. 20. Wigan Cannel coal; of a dark greyish-black colour, and resinous lustre; fracture conchoidal, and not brittle; its coke slightly caked together, and presented a semi-metallic lustre.—No. 21. From St. Helen's, Lancashire, Rushey Park seam; black colour, cubic fracture, and resinous lustre, without any pyrites being visible. It softened slightly, and did not cake together; its coke was hard, porous, and of semi-metallic lustre. —No. 22. From Staffordshire, being a specimen from the Ten Yard seam, near Wolverhampton; colour brownish-black, lustre highly resinous, fracture foliaceous, inclining diagonally to conchoidal; friable, light, not soiling the fingers, and without layers of iron pyrites; extremely intumescent, somewhat resembling a cauliflower. Its coke was highly lustrous, and fine-grained.—No. 23. From the bottom of the same seam; texture slaty; fracture and deportment the same as those of the foregoing, but less inclined to cake and intumesce; coke more lustrous, and coarser grained.—No. 24. From the Oregon Territory; of brownish-black colour, hard, slaty, and of foliaceous fracture; not soiling the fingers, nor in the slightest degree inclined to intumesce or cake; its coke was compact, and scarcely different from the coal. It forms the coating of a seam of the ordinary kind.—No. 25. Anthracite from Wales; of a dark, iron-black colour, and bright metallic lustre, does not soil; it is difficult to break, although friable. Fracture slaty, imperfectly conchoidal in the transverse direction, does not cake together, but retains its lustre. —No. 26. Lignite from Bovey Heathfield, Chudleigh, near Exeter, Devonshire; of earthy-brown colour, and of fibrous and foliaceous

(1) Chem. Soc. Qu. J. I, 318.

Fuel.

structure; exposed to the sun, or in water, it decrepitates, and in the latter falls entirely to pieces; it does not soil; slightly caking.—No. 27. A variety of turf.

The coals of Tuscany have been analysed by La Cava(1), who has investigated the following kinds: No. 28. Coal from the Monte Massi. A poor coal, devoid of lustre, and burning with a bright flame; spec. grav. from 1·36 to 1·39; it yielded from 42·43 to 43·46 per cent of volatile constituents, and left from 57·57 to 56·54 per cent of coke.—No. 29. Coal from the Monte Bomboli. A bituminous coal, burning with a feeble flame, and becoming soft and intumescent; spec. grav. from 1·38 to 1·40. It yielded from 39·2 to 38·7 per cent of volatile matter, and from 60·7 to 61·26 per cent of coke.

The fossil coals of Hungary have been studied at great length by C. M. Nendtvich(2) of Pesth. He has examined the following varieties which for the most part are allied to brown-coal, the specimens only of two localities being ordinary coal.

A. Coal from the district of Barany, more ancient coal; strata alternating with slate and sandstone of the coal formation, varying from 5 to 8 feet in thickness. Colour jet-black, with a highly fatty lustre; greasy to the touch. Fracture uneven, and somewhat slaty; friable, and crumbling to pieces when exposed to the air. Very bituminous, strongly caking, rich in iron pyrites; it yielded from 77 to 84 per cent of coke.—No. 30. From the pit of Ign. Rosman.—No. 31. From that of Joseph Andrassevich, both being situated near Fünfkirchen.—No. 33. From the Barbara pit, near Szabolcs.—No. 32. From Francis's pit, likewise near Szabolcs.—No. 34. From the Michael pit, near Vassas.—No. 35. Spherical coal from the estate of the Royal University at Vassas: spherically conchoidal, nests peculiarly embedded in the foregoing variety. It is not altered in the air.

B. Coal of the district of Krassoë (Banat), which is the best coal found in Hungary. Colour jet-black, fracture uneven, coarse-grained, frequently slaty, of a dull, fatty lustre, with strata of fibrous coal. It does not crumble when exposed to the air, and contains but a very small amount of iron pyrites. It usually contains from 2·70 to 3·70 per cent of water.—No. 36. Is from the pit of Purkari.—No. 37. From the pit of Gerlistye.—No. 38. From the Marcus pit.—No. 39. From the Simon and St. Anton pits.

C. Coals of the districts of Gran and Comorn; which belong to

(1) J. Pharm. [3] XII, 303.
(2) J. Pr. Chem. XLI, 8; XLII, 365; Jahrb. Pr. Pharm. XVI, 78.

the most ancient brown-coal formations, varying several fathoms in thickness. Colour black, lustre dull, fracture slaty, and frequently conchoidal. They present a rhomboidal cleavage, and are difficultly friable; when pulverized they are of a brown colour; their spec. grav. varies between 1·34 and 1·49. When exposed to the air they crumble; they are very rich in iron pyrites. No. 40. From Tokodt.—No. 41. From Csolnok.—No. 42. From Sárisáp, all in the district of Gran.—No. 43. From Zsemle, in the district of Comorn.

D. Brown-coals from the Brennberg coal-mines, situated 4½ miles from Oedenburg. From a seam resting upon grey sandstone and mica-slate, and presenting a distinctly woody texture, but no impressions excepting those of beech-leaves.

a. From the Rudolph-bed.—No. 44. First variety; colour black; streak brown, lustre dull; texture remarkable for its delicate appearance; longitudinal fracture somewhat slaty, transverse fracture uneven and conchoidal. The cleavage-planes exhibit traces of iron pyrites. Persistent in the air; spec. grav. = 1·285.—No. 45. Second variety; colour darker; streak similar to that of No. 40; lustre satiny; texture delicately fibrous, like that of ebony. The fracture resembles that of No. 44, and exhibits traces of iron pyrites and gypsum. Spec. grav. = 1·300.

b. Of the Joseph-bed. No. 46. Third variety, similar to No. 44, but exhibiting in the transverse fracture almost rectangular planes of cleavage; hence the great inclination to break into cubes. It contains the same mineral admixtures. Spec. grav. = 1·289.—No. 47. Fourth variety, almost devoid of woody structure; exhibiting longitudinal striæ of a vitreous lustre; in other respects resembling No. 46. Spec. grav. = 1·334.

The combustion of the coals was effected with protoxide of copper in an apparatus similar to that devised by Dumas for the determination of the equivalent of carbon. The nitrogen was not estimated; the sulphur, however, was determined in the four last analyses in the usual manner with nitre and carbonate of potassa. The results obtained by this method include the sulphur contained in coals in the form of sulphates, a circumstance which renders these determinations of less value.

Practical Value of different Varieties of Coal.—Analyses of fuels performed in the ordinary manner, although well calculated for the determination of their theoretical value, are nevertheless quite inadequate to convey a correct idea of their practical worth, inasmuch as they leave out of consideration some elements, which, unessential in

Practical value of different varieties of coal.

a theoretical point of view, exert a remarkable influence as soon as the results obtained are to be applied on a large scale. In order to obtain results trustworthy for practical purposes, a number of British chemists and engineers, under the direction of De la Beche and Playfair(1), have conducted a very important inquiry into the value of a great many British coals, of a few varieties of foreign coal, and also of some artificial fuels, with particular reference to their employment in steam-navigation. This value depends upon the power of evaporation, *i. e.* the quantity of steam which a given weight of fuel is capable of generating (in a certain time), on the space which this weight of fuel occupies in the vessel, and lastly, on the crumbling during the journey.

The evaporative power of the fuels was ascertained on a large scale by combustion under a steam-boiler which was so arranged, that the necessary corrections being made, the quantity of fuel consumed in heating the water to 100^0 could be deducted, in order to determine the amount of water of this temperature, which had been converted into steam. Under the head of corrections we find the imperfect combustion of the coal duly considered, inasmuch as the particles found among the ashes are introduced into the calculation; the analysis, however, of the gases carried off in the chimney, exhibited only carbonic acid, sulphurous acid, oxygen, and nitrogen, which would indicate that no unburned particles were lost in this manner, a result which is not in accordance with ordinary experience. For the sake of comparison, the theoretical value was determined by elementary analyses performed by Wrightson, for which we refer to the table, and by ignition with an excess of litharge, according to the method proposed by Berthier.

The space which fuel occupies in stowage cannot of course be determined by its spec. grav., but has, in consequence of the interstices, to be ascertained by direct measurement. This factor, which is of extreme importance in steam-navigation, becomes reduced the more the cleavage of the coal, or the shape of the fuel approaches the form of a cube. In order to attain, at least, a relative idea of the waste occasioned by transport, *i. e.* of the attrition of the individual pieces of coal against each other, and conversion of unbroken coal into dust unfit for use, which is occasioned by the motion of the vessel, the various specimens were rotated in a drum for the same length of time, and the dust thus produced, separated and weighed. Whilst we refer to the report for the individual experiments, for the correc-

(1) Mech. Mag. 1848, Nr. 1285—88; Dingl. Pol. J. CX, 212, 263.

COMPOSITION OF VARIOUS KINDS OF FUEL.

KIND OF FUEL.		Number.	100 parts of the dry fuel							100 parts of fuel in the natural state lose at 100° C. water.	Spec. grav.	
			contain:					leave:				
			Carbon.	Hydrog.	Nitrogen.	Sulphur.	Oxygen.	Ash.	Coke.			
Welch coals	Graigola	48	84·87	3·84	0·41	0·45	7·19	3·24	85·5	1·06	1·300	De la Beche and Playfair.
	Anthracite, Jones & Co.	49	91·44	3·36	0·21	0·79	2·58	1·52	92·2	2·44	1·375	
	Old-Castle Fiery Vein	50	87·68	4·89	1·31	0·09	3·39	2·64	79·8	0·74	1·289	
	Ward's Fiery Vein	51	87·87	3·93	2·02	0·83	7·04		—	1·27	1·344	
	Binea Coal	52	88·66	4·63	1·43	0·33	1·03	3·96	88·1	—	1·304	
	Llangennech	53	85·46	4·20	1·07	0·29	2·44	6·54	83·7	—	1·312	
	Pentrepoth	54	88·72	4·50	0·18	—	3·24	3·36	82·5	0·78	1·310	
	Pentrefelin	55	85·52	3·72	trace	0·12	4·55	6·09	85·0	0·70	1·358	
	Duffryn	56	88·26	4·66	1·45	1·77	0·60	3·26	84·3	—	1·326	
	Mynydd Newydd.	57	84·71	5·76	1·56	1·21	3·52	3·24	74·8	0·67	1·310	
	Threequarter Rock Vein	58	75·15	4·93	1·07	2·85	5·04	10·96	62·5	—	1·340	
	Cwm Frood „ „	59	82·25	5·84	1·11	1·22	3·58	6·00	68·8	—	1·255	
	Cwm Nanty-gros	60	78·36	5·59	1·86	3·01	5·58	5·60	65·6	—	1·280	
	Resolven	61	79·33	4·75	1·38	5·07	9·41		83·9	—	1·320	
	Ponty-Pool	62	80·70	5·66	1·35	2·39	4·38	5·52	64·8	—	1·320	
	Bedwas	63	80·61	6·01	1·44	3 50	1·50	6·94	71·7	—	1·320	
	Ebbw Vale	64	79·78	5·15	2·16	1·02	0·39	1·50	77·5	—	1·275	
	Porthmawr Rock Vein	65	74·70	4·79	1·28	0·91	3·60	14·72	63·1	—	1·390	
	Coleshill	66	73·84	5·14	1·47	2·34	8·29	8·92	56·0	—	1·290	
Scotch coals	Dalkeith Jewel Seam	67	74·55	5·14	0·10	0·33	15·51	4·37	49·8	—	1·277	
	„ Coronation „	68	76·94	5·20	trace	0·38	14·37	3·10	53·5	—	1·316	
	Wallsend Elgin	69	76·09	5·22	1·41	1·53	5·05	10·70	58·4	—	1·200	
	Fordel Splint	70	79·58	5·50	1·13	1·46	8·33	4·00	52·0	—	1·250	
	Grangemouth	71	79·85	5·28	1·35	1·42	8·58	3·52	56·6	—	1·290	
English coals	Broomhill	72	81·70	6·17	1·84	2·85	4·37	3·07	59·2	—	1·250	
	Park End, Lydney	73	73·52	5·69	2·04	2·27	6·48	10·00	57·8	—	1·283	
Irish coals	Slievardagh	74	80·03	2·30	0·23	6·76	10·80		90·1	—	1·590	
Foreign coals	Island of Formosa	75	78·26	5·70	0·64	0·49	10·95	3·96	—	—	1·240	
	Borneo, Labuan variety	76	64·52	4·74	0·80	1·45	20·75	7·74	—	—	1·280	
	„ three-feet seam	77	54·31	5·03	0·98	1·14	24·22	14·32	—	—	1·370	
	„ eleven-ft. seam	78	70·33	5·41	0·67	1·17	19·19	·23	—	—	1·210	
Patent fuels	Wylam's	79	79·91	5·69	1·68	1·25	6·63	4·84	65·8	—	1·100	
	Bell's	80	87·88	5·22	0·81	0·71	0·42	4·96	71·7	—	1·140	
	Warlich's	81	90·02	5·56	trace	1·62	2·91		85·1	—	1·150	

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Practical value of different varieties of coal.

tions and calculations, as well as for the comprehensive conclusions which follow, we here communicate only the most important practical results in a tabular form. I. "Economical (practical) evaporative power," *i. e.* the number of pounds of water at 100° converted into steam by 1 lb. of fuel. II. The same, after deducting the portion of coke contained in the ash. III. Theoretical power of evaporation, *i. e.* the number of pounds of water of 100° which are evaporated by 1 lb. of fuel, calculated from the experiment with litharge. IV. Weight of the fuels per cubic foot of stowage. V. Weight of the same by the solid cubic foot calculated from the specific gravity; both in pounds. VI. Percentage loss by attrition. VII. Evaporative power according to the stowage, *i. e.*, the number of pounds of water of 100° evaporated by 1 cubic foot (stowage) of fuel, calculated from IV. and II. All the measures and weights employed are English.—The numerical order corresponds to that of the table facing this page.

Source of the fuels and the kind.	Number.	I.	II.	III.	IV.	V.	VI.	VII.
Welsh coals	48	9·35	9·66	16·72	60·17	81·11	49·3	581·20
	49	9·46	9·70	13·84	58·25	85·79	68·5	565·02
	50	8·94	—	16·38	50·92	80·42	57·7	455·18
	51	9·40	10·60	16·40	57·43	83·85	46·5	608·78
	52	9·94	10·30	16·49	57·08	81·36	51·2	587·92
	53	8·86	9·20	17·02	56·93	81·85	53·5	523·75
	54	8·72	8·98	16·24	57·72	81·73	46·5	518·32
	55	6·36	7·40	15·91	66·17	84·73	52·7	489·62
	56	10·14	11·80	15·64	53·22	82·72	56·2	540·12
	57	9·52	10·59	15·81	56·33	81·73	53·7	536·26
	58	8·84	—	13·89	56·39	83·60	52·7	498·46
	59	8·70	9·35	14·75	55·28	78·30	72·5	480 90
	60	8·42	8·82	15·45	56·00	79·86	55·7	471·52
	61	9·53	10·44	16·76	58·66	82·35	35·0	459·02
	62	7·47	8·04	14·31	55·70	82·35	57·5	416·07
	63	9·79	9·99	14·70	50·50	82·60	54·0	494·39
	64	10·21	10·64	16·68	53·30	78·81	45·0	455·19
	65	7·53	7·75	12·92	53·30	86·72	62·0	401·34
	66	8·00	8·34	13·63	53·00	80·48	62·0	424·00
Scotch coals	67	7·08	7·10	13·77	49·80	79·67	85·7	352·58
	68	7·71	7·86	12·80	51·66	78·61	88·2	398·29
	69	8·46	8·67	15·15	54·60	78·61	64·0	460·82
	70	7·56	7·69	15·12	55·00	78·61	63·0	415·80
	71	7·40	7·91	14·85	54·25	80·48	69·7	401·45
English coals	72	7·30	7·66	13·20	52·50	77·99	65·7	383·25
	73	8·52	8·98	—	54·44	80·05	55·0	463·86
Irish coals	74	9·85	10·49	16·21	62·80	99·57	74·0	618·58
Artificial fuels	79	8·92	9·74	15.02	65·08	68·63	—	580·51
	80	8·53	8·65	14·87	65·30	71·12	—	557·00
	81	10·36	0·60	16·42	69·05	72·25	—	715·35

Adaptation of British coals for the preparation of gas.

Adaptation of British Coals for the Preparation of Gas.—Fyfe(1) has investigated the various kinds of English coal, in reference to their suitability for the preparation of gas, and has arrived at the following results:

Kind of coal.	Spec. Grav. of the gas.	Percentage condensable by chlorine of the gas.	Cubic foot of gas burnt in	Cubic feet of gas yielded by 1 ton of coal.
English caking coal . .	0 464		—	
,, ,, from Newcastle	—	3·5 to 5·5	47 m. 20 s. to 50 m. 25 s.	8000
Yorkshire Parrot coal . .	—	7·66	52 m. 30 s.	11500
Wigan Cannel coal . .	0·460 to 570	7·55	57 m.	9500 to 11500
Scotch Parrot Cannel coal	—	9 to 20 in the average 15	56 s. to 94 s.	9500

Richardson(2) has analysed, with the following remarkable results, the ashes of the coal which is used at Kelso, in Scotland, and probably obtained from the neighbourhood of Berwick. In 100 parts: Titanic acid 7·01, silicic acid 1·84, sulphuric acid 21·20, chlorine 9·57, protoxide of cadmium 1·42, sesquioxide of iron 26·99, protoxide of nickel 1·38, protoxide of zinc 2·03, magnesia 1·01 potassa 18·34, soda 6·87.—If sulphuric acid and chlorine be distributed among the bases, titanic acid, silicic acid, and sesquioxide of iron, remain in almost exactly the same proportion in which they exist in Mosander's titanic iron-ore from Arendal, in Norway.

Carbonization of Wood by means of Steam.—In the powder-mills at Esquerdes near St. Omer, some experiments on a large scale have been conducted by Violette(3), upon the carbonization of wood in heated aqueous vapour. The conception of this experiment is of an older date, and belongs to Thomas and Laurens, who were engaged in similar pursuits. Violette has studied the applicability of the process to the product employed in the manufacture of gunpowder, which, as is well known, is imperfectly carbonized wood; he used for this purpose a peculiarly constructed apparatus in which the vapour generated is heated to several hundred degrees in coils of tubes, before it is passed into the carbonizing retorts. His experiments yielded the following results:

(1) Edinburgh New Phil. Journ. 1848, Nr. 2 and 3; Dingl. Pol. J. CXI, 31.

(2) Private communication.

(3) Ann. Ch. Phys. [3] XXIII, 475; Compt. Rend. XXVI, 683 (in abstr.); Dingl. Pol. J. CIX, 137.

Carbonization of wood by means of steam.

		Duration of each experiment.	Consumption under the steam-boiler. Coal.	Consumption in heating the steam. Wood.	Quantity of wood to be charred.	Produce of brown charcoal.	
						Absolute	Percentage
Mean	First series of experiments .	$2^h\ 11^m$	$29^k{\cdot}7$	$21^k{\cdot}3$	$25^k{\cdot}0$	$8^k{\cdot}63$	34·01
Mean	Second improved series of experiments . .	$2^h\ 20^m$	$21^k{\cdot}0$	$14^k{\cdot}8$	$28^k{\cdot}1$	$10^k{\cdot}27$	36·50
Mean from 4 years	Old process in cylinders . .	—	—	—	—	—	14·08 to 17·81 black charcoal

These experiments exhibit a gain in time, and in quantity, chiefly however in quality, since the vapour carries off all the tarry matter, and prevents the formation of that dense tarry coal which is so prejudicial to gunpowder. The production of 100 kilogr. of carbon according to the old process costs 15 fr.; by the new method it costs only 12 fr. when the spiral is heated with wood, and 8·9 fr. when coke is employed.

Manufacture of Stearin.—According to a cheap method proposed by Milly(1) for the manufacture of stearin, the tallow is allowed to boil for half an hour with dilute sulphuric acid, 15 per cent of oil of turpentine being subsequently added. The mixture is cooled in tinned iron cases, and then pressed in the ordinary manner.(2)

Application of Vegetal Fibre; Dyeing. Distinction between various Woody Fibres.—A fraudulent trade having sprung up in consequence of spinning and weaving linen mixed with cotton, a practice now very general, it has become highly desirable to find a simple and ready means of distinguishing the fibres of hemp from those of cotton.

The society for the promotion of the arts and manufactures in Prussia has awarded a prize to F. S. C. Lehnerdt(3), for the process proposed by him. The dry specimen, after being completely freed from the dressing by means of soap and water, &c., is immersed to about half its length in sulphuric acid of 66^0 B = 1·834 spec. grav. for a period of from 1 to $1\frac{1}{2}$ minute; it is then thrown into water,

(1) Dingl. Pol. J. CX, 437.

(2) An improved apparatus for pressing the mixture of fatty acids obtained by the ordinary process of manufacturing stearin is described: Bull. Soc. d'Enc. 1848, 88; Dingl. Pol. J. CX, 112.

(3) Verh. Gew. Bef. Pr. 1847, 19. 1848, 24

Application of vegetal fibre; Dyeing. Distinction between various woody fibres.

allowed to remain quietly for a few moments, and subsequently washed out and dried. The acid corrodes cotton much more rapidly than it attacks linen, hence mixed fibres are merely thinned, while fibres of pure cotton are entirely destroyed. However, as pure linen is likewise rendered thinner, the test in the first case is somewhat doubtful; in the second case, however, it is perfectly conclusive. In the case of coloured specimens it is better that they should be previously decolorized or bleached.

The same process had been described at an earlier period by Kindt(1) of Bremen.

In a similar manner M. Vincent(2) has endeavoured to find a method of distinguishing the fibre of *Phormium tenax*. In the first place, he found that cold nitric acid of 36° B. imparted a red colour to these fibres, but has no action upon those of pure hemp. Subsequently he preferred the use of chlorine-water for the same purpose. The fibre of *Phormium tenax*, if immersed therein from 2 to 3 hours, and treated, after pouring off the chlorine-water, with ammonia, assumes a violet colour, the order of treatment, however, must not in this case be reversed; the fibres of hemp, especially when well steeped, of *Agave americana* and *foetida*, (Martinique) *Bromelia*, *Hibiscus cannabinus*, *Lagetto* (Domingo), *Crotalaria juncea* (India), *Abaca* (Manilla), and of *Corchorus capsularis* likewise become violet, but less intensely; the fibre of *Asclepias gigantea* and of flax are not affected by this treatment.—We leave it undecided whether this test is adequate to the purpose, and whether, with less careful preparation of the fibre, it may not lead to inaccurate results.

"Antichlore."—As an "antichlore," *i. e.*, as a means of obviating the pernicious after-effect of chlorine (hypochlorites) upon the pulp of paper or stuffs which have been bleached therewith, manufacturers have hitherto been in the habit of using sulphite of soda, whose action upon the adhering bleaching salt, which cannot be removed by washing, gives rise to the formation of sulphate of soda and chloride of sodium. Notwithstanding the satisfactory results obtained by this method, the readiness with which the hyposulphite undergoes decomposition, and the difficulty of preserving it, have induced Bobiere and Moride(3) to recommend a salt of tin (chloride of tin) as a substitute worthy of being tested on a large scale.

(1) Ann. Ch. Pharm. LXI, 253; Phil. Mag. [3] XXXI, 157; J. Pharm. [3] XI, 324; Dingl. Pol. J. CII, 334; together with the earlier tests, in Dingl. Pol. J. CV, 189.

(2) Compt. Rend. XXVI, 598.

(3) Compt. Rend. XXV, 592; Dingl. Pol. J. CVI, 394; Bull. Soc. d'Enc. 1848, 352

For the preparation of tin-salt according to the process recommended by Nöllner, we refer to Vol. I. p. 334. Dyeing with madder.

Dyeing with Madder.—Schunck's(1) investigations into the chief constituents of madder, as also into the principal questions respecting its use in dyeing, have been already communicated, Vol. II, p. 77. Schunck draws from his experiments some explanatory inferences, which are of interest to the practical dyer.

In the usual mode of dyeing, the entire root of the madder is employed, and consequently its various constituents are simultaneously brought into action; this at once explains the necessity of many practical rules of manipulation, which have been pointed out and established by experience. Thus it is a generally recognized fact, that beautiful and durable colours cannot be obtained, unless lime be present in the dye-vat, this earth being either derived from the root, or from the water, or from some other source. If madder be treated with dilute hydrochloric, or sulphuric acid, the specimen, after washing, when compared with an unchanged counter-specimen, exhibits a decided diminution of colouring power, which may, however, be again restored, or even heightened, by lime-water, or milk of lime. Lime, however, does not appear to heighten the power of alizarin in the isolated state, on the contrary, it diminishes it in proportion as this principle combines with the alkaline earth. The colouring power of madder is likewise injured by the rubiacin, and the alpha- and beta-resin it contains; these substances especially affect red, black and purple, and impart a yellowish tint to white grounds. Their injurious influence, however, is nearly perfectly obviated by lime. The same earth prevents also the still more deleterious effect of pectic acid, which almost completely destroys the colouring power of alizarin; pectate of lime exerts no action whatever. According to an experiment of Schunck, the bases of the mordant (alumina and sesquioxide of iron) possess a far greater disposition to combine with pectic acid than with alizarin, and take it up from the dye-vat in preference to the latter, unless prevented by the presence of lime. Rubiacin, and the resins, comport themselves in a similar manner.—Hence the lime is necessary as a sort of preservative which combining with the injurious constituents of the madder, and removing them from the sphere of action, allows the alizarin a free and undisturbed effect. From these statements, we perceive at the same time that the favourable influence of lime has a limit; an excess of

(1) Loc. cit. II, 77; also in Dingl. Pol. J. CX, 40.

Dyeing with madder.

this earth withdrawing a certain amount of alizarin from the process of dyeing.

The deportment of xanthin differs, in some respects, from that of the other secondary constituents of madder. The boiling solution of this substance has no effect upon mordantized cloth, unless it be exposed to the oxidizing influence of the air, when it imparts a dark-brown colour. Cloth not mordantized assumes a brownish tint. During the process of dyeing, xanthin is evidently more or less oxidized, and thus becomes analogous to the resins and to rubiacin, imparting, like these latter substances, a brown colour to the cloth.

Other bases can be used as advantageously as lime, in the process of dyeing. In practice, as may be readily imagined, the dyer never succeeds in entirely preventing, by means of lime, the deleterious action of the secondary constituents of madder, and owing to the intervention of these latter principles, the tone of colour is almost invariably more or less dull and impure. In order to obviate this evil the cloth, after having been dyed, has still to be treated with a boiling solution of soap. This operation, which is termed the process of raising the colour, is, as it were, a continuation of the action of the lime, and is intended to remove the pectic acid, the resins, rubiacin, and xanthin, which are soluble in the alkali, whilst the fatty acid combines with the alizarin, as well as with the alumina and sesquioxide of iron contained in the mordant.

Schunck has succeeded in establishing, beyond all doubt, the existence of alizarin in dyed cloth, and with some degree of probability also, the presence of the other principles of madder. Also in cloth whose colour had been raised, he has found alizarin, and fatty acids.

The observations of Schunck afford no less important information regarding the product known under the name of garancin. By this technical expression, as is well known, is designated a preparation from madder, which is obtained by treating it with hot sulphuric acid, and subsequent washing. Garancin offers some very great advantages, inasmuch as it produces at once superior colours, whilst the white portions of the cloth, which in the ordinary process so readily assume a brown, or yellowish tint, remain perfectly unaltered if this preparation be employed. According to Schunck, the treatment of madder with acid produces two effects. Part of the alizarin exists in madder-root in combination with lime and magnesia, being in this form perfectly useless in dyeing; this part is set free by the acid, and thus rendered available. Moreover, the injurious xanthin,

so far as it is not decomposed by the acid, is removed in the process of washing, since it is not precipitated by acids. Schunck observes, that the statements hitherto made regarding the destruction of the deleterious constituents of madder, and of its woody fibre, are not supported by facts, or only true for part of the xanthin, this latter constituent being converted, by the action of hot acid, into a dark-green substance which imparts to garancin its dark colour. Dyeing with madder.

Schunck concludes his treatise with the proposal to exhaust the madder, in the places in which it is cultivated, with boiling water, and to precipitate the solution with acids. The precipitate, which contains all the colouring matter, might be brought into commerce, instead of the madder itself, with a great saving in the cost of carriage. In a publication of the same investigation, which appeared somewhat later, the author has introduced some essential modifications into the preceding theory: compare Vol. II, p. 85.

J. Higgin's(1) investigation of madder completes, in another direction, the practical results obtained by Schunck. Higgin confirms the existence of the three colouring principles, alizarin, rubiacin, and xanthin, which had been pointed out by Schunck, and establishes, at the same time, an intimate relation between these substances.—According to his experiments, an essential difference is observed between the action of hot and of cold water upon madder. The cold extract, after one or two hours, was found to contain no longer any xanthin, and very little rubiacin; an extract, completely freed from alizarin, and which had ceased to impart a red colour to cloth, after the lapse of some time, again exhibited the presence of alizarin, and imparted a red colour, the xanthin having disappeared. Hence Higgin concludes that, in this case, xanthin is converted into alizarin, whilst other observations lead him to believe that rubiacin is an intermediate product of this metamorphosis. This remarkable transformation does not depend upon oxidation, but upon a fermentation probably induced by a gluten-like constituent of madder. This fermentation most readily takes place at a temperature of from 49^0 to 54^0, and is completed in about half an hour. The better kinds of madder contain more ferment than is required by their amount of xanthin. When madder is exhausted with boiling water, this transformation is prevented.—Experiments made in corroboration of these statements led to the following results: 1. The colouring power of madder appeared to be heightened in proportion to the

(1) Loc. cit. Vol. II, 85.

Dyeing with madder.

quantity of xanthin intentionally added before the process of fermentation; 2. Madder, or garancin, when treated with hot water, colours much less intensely than when cold water is employed; 3. Madder, when freed from xanthin, produces a much more feeble colour than it does when allowed to ferment with the latter substance.

In practice it is usual to commence with a low temperature, and to allow it gradually to rise, so that after an hour it reaches to 50^0 which, according to Higgin, is the temperature of fermentation. The alizarin existing in the madder is at once available, while that which is produced in the process comes into action after the former has been consumed. After the process of dyeing, rubiacin, &c., remain, and deaden the tone of colour. Lastly, Higgin explains why inferior varieties of madder, containing xanthin, are in practice advantageously mixed with better kinds, and why fermentation in the vat is found to improve many kinds, especially the Dutch variety.

Respecting the practice of dyeing, compare also Vol. II, p. 61.

Waterproof Paper.—Bossy(1) has taken out a patent for rendering paper impervious to water, by means of an alumina-soap. In order to effect this, he impregnates the fibres of the paper consecutively with caustic lime and solution of soda, then with a bath of cocoa-soap and pulverized plantain-seeds, and finally with a solution of sulphate of alumina.

Hair-Varnish.—Williams(2) has published an original method of fabricating the so-called "artificial hair," for the purpose of obtaining a cloth applicable to the covering of furniture, &c. Ordinary fibrous materials, such as cotton, flax, silk, and wool, are immersed in the hair-varnish discovered by himself, and then dried at a moderate heat. The hair-varnish is prepared by dissolving from 10 to 40 parts of the clippings of pigs' bristles, or horse-hair, in 100 parts of desiccative oil, or of linseed-oil varnish.

Preservation of Wood.—Hutin and Boutigny(3), starting from the view that the absorption of moisture, and of agents destructive to wood, is due to the fibre-tubes, have given the following process for permanently closing the mouths of the vessels which lead to the interior of the wood. One end of the railway-sleepers, for which this process is chiefly intended, is immersed in a carbo-hydrogen, oil of schiste, f. i., which is then lighted. After the flame is extinguished, the end is dipped to a depth of from 1 to 2 inches in a

(1) Lond. J. of Arts. March. 1846; Bull. Soc. d'Enc. 1847, 597.
(2) Monit. Industr. 1848, No. 1247; Dingl. Pol. J. CIX, 74.
(3) Compt. Rend. XXVI, 481; J. Pr. Chem. XLV, 383; Dingl. Pol. J. CVIII, 373.

mixture of pitch, tar, and gum-lac, the whole being then tarred in the ordinary manner. Preservation of wood.

Ch. Payne(1) proposes to precipitate within the pores of the wood a solution of sulphide of barium, by means of sulphate of iron. He forces the solution into the pores of the wood by first exhausting the air by means of aqueous vapour, and then with the air-pump, and by finally submitting the liquids to a pressure of from 110 to 140 lbs. to the square inch. Sulphides of potassium and sodium have been recommended as substitutes for sulphide of barium.

Tanning.—M. A. Turnbull(2), justly considering that lime which is left in the hides after the process of unhairing, induces a series of changes of the tannic acid, in consequence of which the tanning liquors are weakened in strength, proposes to extract the lime previous to tanning, by means of a strong solution of sugar (molasses); in this manner a saving is effected both in time and material.

Gun-cotton and Collateral Matters. — From his peculiar views regarding the nature of nitro-sulphuric acid, Schönbein(3) was induced to submit a number of organic substances to the action of this acid; in the course of this investigation, which extended over the latter part of the year 1845 and the beginning of 1846, he discovered gun-cotton. In the two following years, our knowledge of this interesting and much talked of substance has been considerably enlarged.

Composition of Gun-cotton.—The investigations of Kerckhoff and Reuter(4) have afforded the most important results. The authors, in the first place, discuss some of the circumstances which appear to have an influence upon the results of analysis. To these belong: 1. The impurity of the cotton-wool employed. The cotton is in general contaminated with fatty matters, by which, on immersion in the acid, an imperfect wetting, and consequently an unequal action is occasioned. This inconvenience, however, may be completely obviated by boiling the cotton-wool in a moderately strong solution of soda, washing, rinsing with dilute nitric acid, and again repeatedly washing

(1) Lond. J. of Arts, 1847, 185; Verh. Gew. Bef. Pr. 1847, 71.
(2) Ann. Ch. Phys. [3] XXI, 74.
(3) Phil. Mag. [3] XXXI, 7; Arch. Ph. Nat. IV, 20.
(4) J. Pr. Chem. XL, 262, 284; Compt. Rend. XXIV, 46. Compare also the *résumé* of the investigations upon gun-cotton in J. Pr. Chem. XL, 193 and XLIII, 242; Ann. Ch. Pharm. LXIV, 391.

Composition of gun-cotton.

until the water no longer affords the reaction of nitric acid. 2. The manner in which the prepared gun-cotton is dried. The authors after having vainly endeavoured to obtain constant results with substances dessicated at temperatures exceeding 100°, remarked that gun-cotton, after drying in air at 105°, evolves the odour of nitrous acid, and that, when dried between 105° and 115°, the carbon increases with the rise of temperature, from 24·74 to 27·22 per cent, and the hydrogen from 2·34 to 2·80 per cent. Hence it cannot be doubted that, at a temperature which approaches so nearly the point at which this compound is inflamed (131°), the nitric acid and the organic substance in the gun-cotton mutually decompose each other, the nitric acid being reduced without an actual explosion.

By these experiments Kerckhoff and Reuter have been led to adopt the following process. They immerse the cotton-wool, purified in the above-mentioned manner, in a mixture of equal parts of strong nitric acid and ordinary sulphuric acid, in which it is allowed to remain for at least three minutes. The preparation, when finished, is pressed out, washed first with rain-water, and subsequently with distilled water, until the acid is entirely removed, then pressed between bibulous paper, and finally entirely freed from water by drying *in vacuo* at the ordinary temperature which, however, should not exceed 15°. The drying succeeds without difficulty, the gun-cotton being but very slightly hygroscopic.

The authors did not venture to make the analysis in the ordinary manner, partly on account of the readiness with which gun-cotton decomposes at temperatures over 100°, the mixing of the substance intended for analysis with warm protoxide of copper being liable to occasion a source of inaccuracy, and partly from fear of the violence attending the decomposition of the two bodies. They preferred to perform this operation in an apparatus similar to that employed by Thénard and Gay-Lussac fifty years ago. The substance, compressed into little balls, was introduced in small portions at a time, and the gases arising from its explosion passed over ignited protoxide of copper and metallic copper, and subsequently, for the purpose of weighing the carbonic acid and water, collected in the ordinary apparatus. The nitrogen-determinations were made, with some modifications, according to the process proposed by Dumas.

E. Schmidt and Hecker(1), previously to entering upon an investigation of gun-cotton, have endeavoured to establish the com-

(1) J. Pr. Chem. XL, 257; Pol. Centr. 1847, 36.

position of cotton itself. The four analyses performed with this view, have not led to a definite solution of the question; the analyses which yielded the largest quantity of carbon differ amongst themselves about 1·27 per cent of carbon, and exceed the theoretical numbers of Payen's formula (C_{24} H_{20} O_{20}) by 0·98 per cent, while, on comparison with those of Baumhauer's (C_{24} H_{21} O_{21}) they exhibit a deficiency of 0·6 per cent. Moreover, the authors have omitted to state how, and to what extent the cotton submitted to analysis was purified; it still contained 1 per cent of ash. If, therefore, the mean value obtained in these four analyses of cotton agrees with the formula proposed by Baumhauer, it is derived from results far too discrepant to allow us to adopt with the authors the latter formula, as being established beyond doubt. Composition of gun-cotton.

The carded cotton-wool was repeatedly immersed in a mixture of sulphuric and nitric acids, (in what proportions is not stated), until it no longer increased in weight. The authors washed the gun-cotton thus prepared, and dried it at from 90° to 100° either in a current of air, or *in vacuo*, till it ceased to diminish in weight; they had recourse to this method after they had found that at the ordinary temperature, all the water could not be expelled *in vacuo* over sulphuric acid, and that this substance commences to be decomposed at as low a temperature as 110°.

Walter Crum(1) proceeded in a very circumspect and careful manner with the preliminary preparation of the raw cotton. The kind he employed was a fine specimen from Sea Island, which was carded and bleached, boiled in caustic soda, treated with chloride of lime, boiled again with caustic soda, and finally digested with dilute nitric acid. After each operation the cotton was introduced into a filtering bag, and washed. When thus purified, it had lost 5·6 per cent in weight, and contained only 0·09 per cent of ash. In order to convert the cotton into gun-cotton it was perfectly dried, and introduced in little parcels of 10 grains each, while still warm, into one ounce of acid mixture, consisting of 1 vol. of sulphuric acid, of 1·84 spec. grav., and 3 vols. of nitric acid of spec. grav. 1·517.

The determination of the carbon of the gun-cotton was effected by combustion with chromate of lead, mixed with chlorate of potassa, the carbonic acid being measured. The hydrogen and oxygen were determined together, by a method which was not likely to yield results of great accuracy, namely, by ascertaining the quan-

(1) Phil. Mag. [3] XXX, 426; J. Pr. Chem. XLI, 201; J. Pharm. [3] XII, 296.

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tity of hydrogen in the water, and in the ammonia-compounds, produced during the process of detonation. The nitrogen was determined as nitric acid, or rather as binoxide of nitrogen, according to the author's method, proposed on this occasion for the analysis of nitric acid compounds (comp. Vol. II, p. 222). The specimen subjected to analysis, when dissolved in nitric acid, yielded, after evaporation and ignition, 0·22 per cent of ash, which is more than double the amount contained in the cotton, hence the nitric acid employed could not have been free from impurities.

Thomas Ransome(1), who likewise started with experiments on the composition of cotton itself, arrived at the formula $C_{24}\ H_{20}\ O_{20}$, as did also J. H. Gladstone(2).

Fehling(3), and under his direction Roser and Krauss, have analysed gun-cotton by the ordinary process of combustion with protoxide of copper, the specimens examined being prepared by means of different mixtures of sulphuric and nitric acids, and longer or shorter immersion. At first, chlorate of potassa was employed in addition, but subsequently rejected as superfluous. The nitrogen was determined according to the differential method of Liebig. Fehling, likewise, feared partial decomposition by drying gun-cotton at 100°, and consequently dried the substance submitted to analysis in the air. This imperfect mode of desiccation explains the discrepancies of his results from those obtained by others, especially as regards the lower percentage of nitrogen and the excess of hydrogen; the presence of water, however, should also have depressed the amount of carbon.

Pelouze(4), like his predecessors, has studied the composition of pure cotton, and after repetition of the analysis declared, with Payen, in favour of the formula $C_{24}\ H_{20}\ O_{20}$. According to the former chemist, gun-cotton is decidedly decomposed, with evolution of the odour of nitric acid, at as low a temperature as 100°, but is not perceptibly altered at from 40° to 55°.

All the observers, particularly Fehling, Pelouze, and Kerckhoff, agree in the opinion that the formation of gun-cotton is completed after some minutes, and that no farther action then ensues, however long it subsequently may remain in contact with

(1) Phil. Mag. [3] XXX, 1.
(2) Phil. Mag. [3] XXXI, 519; Chem. Soc. Mem. III, 412.
(3) Dingl. Pol. J. CIII, 220.
(4) Compt. Rend. XXIV, 2; Dingl. Pol. J. CIII, 224; Pogg. Ann. LXXI, 144.

the acid, and likewise that nothing except water is separated from the cotton by the acid. We give the results of the foregoing investigations in the following tables.

Composition of gun-cotton.

ORDINARY GUN-COTTON NOT PURIFIED BY SOLUTION.

	Van Kerckhoff and Reuter.					Hecker and Schmidt.				
Carbon .	24·87	24·59	24·88	25·03	24·66	24·78	25·16	25·73	25·00	26·06
Hydrogen	2·59	2·58	2·53	2·50	2·49	2·75	2·68	2·79	2·77	2·94
Nitrogen .	13·84	14·34	14·03	14·33	14·31	13·50	12·73	12·26	—	—
Oxygen .	58·70	58·49	58·56	58·14	58·54	59·77	59·43	59·22	—	—

	Ransome.		Crum.		Pelouze.	Pettenkofer(1).	Gladstone.
Carbon . .	26·16	26·41	24·69	25·16	25·2 to 25·8	26·03	26·1 to 27·9
Hydrogen .	3·14	3·19	2·48	—	2·9 „ 2·3	2·78	3·22 „ 3·33
Nitrogen . .	10·20	—	13·80	—	12·6 „ 13·0	12·40	12·75
Oxygen . .	69·36	—	59·03	—	59·3 „ 58·9	58·79	—

	Fehling.							
	Immersed in a mixture of from 80 to 90 grms. of nitric acid (1·45) and from 240 to 270 grms. of commercial sulphuric acid.						Again immersed for 10 minutes in a fresh portion of the same mixture.	Gun-cotton from Schönbein.
	2½ Min.	5 Min.	7½ Min.	10 Min.	12½ M.	15 Min.		
Carbon .	25·9	26·7	26·4	25·8	26·1	26·1	25·8	25·9
Hydrogen .	3·7	4·1	3·9	3·8	3·7	3·7	3·9	3·7
Nitrogen .	10·7	10·5	9·5	10·2	11·0	9·3	9·5	9·6
Oxygen .	59·7	58·7	60·2	60·2	59·2	60·9	60·8	60·8

TREATED WITH ETHER.

Schönbein and Böttiger(2):	Flores Domonte and Menard(3):	
	In alcoholic ether.	
Had been dissolved in acetic ether.	Insoluble.	Soluble.
27·43	28·5	23·38
3·54	3·5	2·92
14·26	11·6	11·36
54·77	56·4	62·34

(1) Baier. Kunst- and Gewerbeblatt, Januar, 1847; Dingl. Pol. J. CIII, 219.

(2) Augsb. Allg. Zeitung, 3, Jan. 1847, Beil. S. 21; Dingl. Pol. J. CIII, 220; Pogg. Ann. LXX, 320; Arch. Ph. Nat. IV, 20. 28.

(3) From Recueil, &c. (comp. II p. 3) April, 1847, 104, in J. Pharm. [3] XII, 159; Pogg. Ann. LXXI, 144; Compt. Rend. XXIV, 390.

Formation of gun-cotton.

Formation of Gun-Cotton.—If we start from the fact that, in the metamorphosis of cotton induced by the mixture of acids in the above proportions, no organic matter, but merely water is eliminated, and that no evolution of gas whatever takes place; if, in other words, we consider that the formation of gun-cotton is nothing more than an assimilation of the elements of NO_5 and a separation of water, as has been frequently demonstrated, and is now generally admitted, the results obtained by the above-mentioned analysts would seem to indicate a mutual replacement in the following proportions.

A replacement of 6 HO by 6 NO_5 in the above formula of cotton is assumed only by Crum, while Gladstone alone believes that a substitution of 5 HO by 5 NO_5 takes place. Hence, according to the former, the composition of gun-cotton would be $C_{24}\,H_{14}\,N_6\,O_{44}$, whilst the latter adopts the formula $C_{24}\,H_{15}\,N_5\,O_{40}$. Hecker and Schmidt, on the contrary, assume the expression $C_{24}\,H_{16}\,N_5\,O_{41}$, according to which, the formula $C_{24}\,H_{21}\,O_{21}$ being adopted for pure cotton, 5 HO are replaced by 5 NO_5. If, on the other hand, we admit that cotton contains $C_{24}\,H_{20}\,O_{20}$, Hecker and Schmidt's formula would indicate that in the formation of gun-cotton 4 HO are replaced by 5 NO_5.—Kerckoff and Reuter represent the composition of gun-cotton by the formula $C_{24}\,H_{16}\,N_5\,O_4$, according to which 6 NO_5 are substituted for 7 HO.—Pelouze is of opinion that gun-cotton is $C_{24}\,H_{17}\,N_5\,O_{42}$, 3 HO being replaced by 5 NO_5. Teschemacher and Porrett(1) adduce the formula $C_{24}\,H_{16}\,O_{16}+8\,NO_5$, according to which 8 NO_5 are assimilated with separation of 4 HO. Fehling has endeavoured to prove by his analysis that the explosive cotton is formed, like xyloidin, without the separation of water, and that it contains simply $C_{24}\,H_{20}\,O_{20}+4\,NO_5$; this, however, is certainly erroneous, since the acid employed, in consequence of the formation of gun-cotton, becomes diluted to an obvious extent with water, whose origin would then be perfectly unintelligible.—The formulæ adduced for gun-cotton by other observers are likewise irreconcileable with observation. Ransome's formula $C_{24}\,H_{16}\,N_4\,O_{40}$ requires a replacement of 4 H by 4 NO_5. In a similar manner Schönbein and Böttiger, by analysing gun-cotton, precipitated from its solution in acetic ether, arrived at the formula $C_9\,H_6\,N_4\,O_{13}$, which is inadmissible on account of the circumstances under which the compound is formed. Ransome gives no explanation of what becomes of the liberated hydrogen, since it is neither oxidized by the nitric acid, nor appro-

(1) Phil. Mag. [3] XXX, 273; Chem. Soc. Mem. III, 258.

Formation of gun-cotton.

priated by any simultaneously formed compound, both assumptions being contrary to observation; nor do Schönbein and Böttiger explain in any way the loss of carbon and oxygen as exhibited by their formula.

The results obtained by Flores Domonte and Menard differ farthest from those of other observers, inasmuch as for the portion of gun-cotton which is insoluble in a mixture of alcohol and ether they adduce the formula $C_{24} H_{16} O_{16} + 4 NO_5$(1), and $C_{24} H_{18} O_{18} + 6 NO_5$ for that which is soluble. In the formation of the former 4 HO would have been replaced by 4 NO_5, and in that of the latter 6 NO_5 would have been substituted for 2 HO. The authors enter so little into accurate details in their short report, that no definite opinion can be formed regarding the value of their formulæ.

The preceding synopsis shows that the numerous and comprehensive investigations made have not been able to decide the composition of gun-cotton; in fact, those observers who employed in its purification the solvents which in the meantime had been discovered, have arrived at results most widely differing from those of their predecessors, and also in some measure discrepant among themselves. The difficulty of obtaining the cotton to be employed in a sufficient state of purity, and the want of an unfailing indication when the transformation is complete, the facility with which the compound is decomposed during the process of desiccation, and lastly, the analysis of so explosive a substance itself, all combine in affecting the accuracy of the results. We are, moreover, left in doubt, whether the substance whose analyses we have communicated had been prepared with nitric acid free from nitrous acid, a circumstance which is of some import, inasmuch as Payen has shown that the use of nitrous acid gives rise to the formation of a compound, which, being far less explosive must evidently have a different constitution. And lastly the starting-point, namely the formula of pure cotton is still a point in question, although this uncertainty in no way affects the relative value of the various formulæ. The several observers, as was to be expected, have endeavoured to control their results by determining the increase of weight exhibited by a given amount of cotton after its conversion into gun-cutton. We add these results in the following synopsis:

(1) Loc. cit. II, p. 367, O_6 is given instead of O_{16}, which is evidently an error of the press.

Formation of gun-cotton.

Observer.	Gun-cotton produced from 100 parts of cotton according to the experiments of the various observers.	Quantity from 100 parts of cotton according to the theories of the various observers.
Teschemacher and R. Porrett . . .	154	222
Teschemacher(1)	169	—
W. Crum	177·9	183
Fehling, first series of experiments with 10 grms. of cotton	150 to 160	166
Fehling, second series with 30 grms. . .	160 to 170	
Pelouze	174 to 176	174·9
Hecker and Schmidt	169	167·7
Van Kerckhoff and Reuter	176·2	175·1
Gladstone, with gun-cotton prepared according to Schönbein's method . . .	173 to 175·5	169·4

From this table, it appears that the various authors, with the exception of the two first-mentioned chemists, have in each instance observed pretty nearly the increase of weight which their respective theories require. Farther investigations have to decide whether there exists only one or several kinds of gun-cotton, and, in the former case, what is its composition. Gladstone has found that a large excess of sulphuric acid used in the preparation of gun-cotton is capable of dissolving a portion of the product; this observation appears to throw some light upon several of the numerical results adduced.

Properties of Gun-Cotton.—According to Kindt(2), pure cotton and gun-cotton may be readily distinguished by macerating them in a solution of iodine in iodide of potassium, and adding, after some time, sulphuric acid diluted with 4 parts of water. The former assumes a yellow, the latter a blue colour.

According to Kerckhoff and Reuter gun-cotton is dissolved as easily as cotton at the common temperature, by sulphuric acid of from 1·5 to 1·7 spec. grav.; the solution takes place without colouration. At 100° this solution evolves a considerable quantity of gas, but becomes brown only at a higher temperature; under similar circumstances cellulose assumes a dark colour at as low a temperature as 90°. The gas evolved consists of carbonic acid and binoxide of nitrogen. According to Kerckhoff(3) gun-cotton is slowly dissolved

(1) Phil. Mag. [3] XXX, 258; Chem. Soc. Mem. III, 253.
(2) Pogg. Ann. LXX, 167; Dingl. Pol. J. CIII, 214.
(3) J. Pr. Chem. XL, 285.

Properties of gun-cotton.

by moderately concentrated potassa in the cold, more readily at a temperature of 60°, the two processes appearing to give rise to different products of decomposition. The solution, when neutralized with acetic acid, copiously evolves binoxide of nitrogen, and still more abundantly when sulphuric acid is employed; in no case, however, is a cloudiness perceptible. The liquid thus obtained yields a yellowish precipitate with neutral acetate of lead; after filtration a still farther precipitate takes place on addition of tribasic acetate of lead. This precipitate, when decomposed with hydrosulphuric acid, gave in one case an acid having the percentage-composition of Fremy's tartrelic acid, in another case that of citric acid. The precipitate obtained with the tribasic acetate afforded the percentage-composition of tartrylate of lead. Kerckhoff has not as yet proved the identity of his compounds with the acids mentioned.

R. Porrett(1) exposed a mixture of 1 part of gun-cotton and 20 parts of nitric acid of 1·45 spec. grav., to a temperature gradually rising from 38° to 67°, at which point it was maintained. The whole of the gun-cotton dissolved without evolution of gas, and was precipitated again by dilution with water as a powder possessing the original properties of gun-cotton. When the temperature was increased to 113°, vapours of hyponitric acid were abundantly evolved. By neutralizing, with carbonate of potassa, the nitric acid solution, or a similarly prepared solution in sulphuric acid which exhibited the same deportment, a copious greyish precipitate was formed. This precipitate Porrett believes to be a new vegetal alkaloid; this subject, however, requires farther investigation.

De Vry(2) has prepared pyroxylin from starch in exactly the same manner as from cotton. Cottereau(3), at a subsequent period, has likewise succeeded with this preparation. The former has, moreover, found that pyroxylin is dissolved by nitric acid at a temperature of from 80° to 90°, and is again precipitated of a white colour by addition of sulphuric acid and of water. The precipitate produced by water possesses a bitter taste, and is soluble in alcohol, as also in a large excess of the precipitant. De Vry observes that pyroxylin is reprecipitated from a solution in nitric acid prepared at from 30° to 35°, by sulphuric acid, and that water, on the contrary, precipitates xyloidin. The former substance is insoluble in concentrated acetic acid.

(1) Chem. Soc. Mem. III, 287; Phil. Mag. [3] XXX, 409; J. Pr. Chem. XLI, 208.
(2) Compt. Rend. XXIV, 19.
(3) Compt. Rend. XXIV, 205.

Properties of gun-cotton.

According to Gladstone, gun-cotton is insoluble in water; soluble in sulphuric acid and caustic potassa; difficultly soluble in ammonia, carbonated alkalies, and in nitric and acetic acids.

Payen believes that ether dissolves at least two substances from gun-cotton, whilst, on the other hand, Ménard and Flores Domonte affirm, that in pure ether it is absolutely insoluble. This latter opinion agrees with Gladstone's statement; who found it "nearly insoluble" in strong spirit of wine and in ether, but soluble in acetic ether.

Collodium.—The solubility of gun-cotton in acetic ether, and in acetate of oxide of methyl, as is well known, was discovered at an early period by Richier(1).—Recently a solution of gun-cotton has been imported from America under the name of collodium; the preparation of this solution, which is employed for a variety of purposes, depends upon the following deportment of gun-cotton with solvents. According to Sourisseau(2) and Lepage(3), gun-cotton, when placed in contact with commercial ether, swells up after some seconds to a thick paste-like jelly, without, however, being actually dissolved. On agitating with a farther quantity of ether, or better with a portion of spirit of wine even of the ordinary strength, the jelly is converted into a more or less thick paste-like semifluid mass which constitutes collodium. When spread in thin layers upon glass it rapidly dries to a transparent explosive membrane which becomes highly electric by friction, and may be readily separated from the glass so long as no heat is employed. Grüel(4) has shown, that by covering the inner surface of a glass flask with collodium small balloons may be formed which, when filled with hydrogen, will rise in the atmosphere, even if they be less than 3 inches in diameter.—Collodium, on drying, tightly adheres to the skin, and by this property, as well as by its powerful contraction, is admirably adapted for uniting the edges of wounds. In dressing cuts, collodium offers the additional advantage of being impervious to air and water; on account of these valuable properties this compound appears very likely to become an important and permanent agent in surgery.

(1) Compt. Rend. XXIV, 392.—Recipes for the preparation of collodium: J. Pharm. [3] XIV, 263; J. Chim. Méd. [3] IV, 541; J. Pr. Chem. XLV, 376.

(2) J. Pharm. [3] XIV, 417.

(3) J. Pharm. [3] XIV, 420.

(4) Pogg. Ann. LXXV, 333.

Collodium.

The jelly prepared with ether may be diluted without coagulation with a very large amount of spirit of wine, particularly of strong spirit; after being agitated, and allowed to remain at rest, a perfect solution is obtained which may be filtered; at the bottom of the vessel, however, there almost invariably remains a residue of jelly, together with a great number of unaltered fibres. Different specimens of gun-cotton do not dissolve with equal facility in ether and spirits of wine, the solubility of this substance appears, however, to increase in proportion as moisture is avoided. Cotton, dried previously to being soaked in the mixture of nitric and sulphuric acids, is best suited for the preparation of collodium.

Products of the Decomposition of Gun-Cotton by Explosion.—Jean(1) has found that the products of decomposition which are formed by the explosion of gun-cotton are the same when a similar mode of preparation has been adopted, and *vice versa*.

Hecker and Schmidt have likewise studied the products of explosion. By inflaming gun-cotton in a Toricelli's vacuum they obtained from 1 grm. of substance the following volumes of gas, reduced to 0^0 and $0^m{\cdot}76$ pressure: 1. 556 cc.; 2. 598 cc.; 3. 609 cc.; 4. 589 cc.; being on the average 588 cc. of gas. Qualitative analysis pointed out the presence of carbonic acid, carbonic oxide, nitrogen, binoxide of nitrogen, carburetted hydrogen and water, occasionally also of cyanogen and ammonia; quantitative analysis did not afford very concordant numbers; the following is the mean of several rather discrepant experiments, which we place in juxta-position to the results obtained by Teschemacher and Porrett.

	Hecker and Schmidt.	Teschemacher and Porrett.		
Carbonic acid	20·8	12·92	27·31	Cubic inches from 100 grs.
Carbonic oxide	37·6	20·47	68·24	
Binoxide of nitrogen	17·2	21·94	68·24	
Nitrogen	4·0	4·11	13·65	
Cyanogen	—	7·58	13·65	
Carbide of hydrogen (CH)	4·6	—	—	
Loss and water	15·8	32·98	—	
	100.0 parts by weight.	100·00 parts by weight.	191·09 cubic inches.	

If 100 grains yield 191·09 cubic inches of gas, 1 grm. will

(1) Compt. Rend. XXIV, 1053.

Products of the decomposition of gun cotton by explosion.

correspond to 483 c.c.; a result which does not agree with the numbers observed by Hecker and Schmidt. As, however, no statements have been made respecting the aqueous vapour present, which is probably included in Hecker and Schmidt's numbers, whilst Teschemacher and Porrett operated upon dry gases, it remains uncertain whether the discrepancy of the results is dependent on these different conditions, or whether it arises from a difference either in the quality of the preparation, or in the analysis, or lastly, in the circumstances of combustion.—We see, however, that in the detonation of gun-cotton, the combustion of the elements is very incomplete. A more perfect combustion, and consequently an increased action may, however, be attained by adding substances capable of evolving oxygen. Teschemacher and Porrett obtained in the combustion of 1 part by weight of gun-cotton, with 0·4 of chlorate of potassa, 0·42 parts by weight of carbonic acid, 0·198 carbonic oxide, 0·178 nitrogen, and 0·200 water.

Coathupe(1) has likewise found that the explosive force of gun-cotton is increased when this substance is impregnated with salts evolving oxygen, and that chlorate of potassa is by far the best suited for this purpose.

Schönbein, in the meantime, has taken out an English patent for his discovery, in the name of J. Taylor(2), and he has described the preparation of gun-cotton as follows: Purified cotton is immersed in a mixture of 1 vol. of nitric acid, of a spec. grav. of from 1·45 to 1·50, with 3 vols. of sulphuric acid, of spec. grav. 1·85, after it has cooled down to from 15^0 to 10^0, an uniform impregnation being promoted by agitating and dividing the cotton. The author does not state the duration of the immersion, but recommends to press out the greater part of the acid with a pestle, and to allow the cotton to remain in this state for an hour, when it is washed in a stream of water, until the acid reaction has entirely disappeared, and finally with a very dilute solution of potassa; the product is dried at 65^0. For the purpose of increasing the power of the preparation, it may be impregnated with a solution of nitre in 160 parts of water.—At an earlier period, however, the *Direction des poudres et salpêtres*(3) had proved by ballistic experiments, that the increase of the effect

(1) Phil. Mag. [3] XXXI, 152.
(2) Report of Patent Invent., May, 1847. 292; Dingl. Pol. J. CIV, 450.
(3) Dingl. Pol. J. CIII, 48.

thus obtained is but trifling, and by no means in proportion to the greater expenditure.

Gradual decomposition of gun-cotton.

Gradual Decomposition of Gun-cotton.—The products of the slow decomposition of gun-cotton at 100° have been studied by Kerckhoff and Reuter. They found that the decomposition *in vacuo* proceeds slowly, the gradual loss of weight, after 12 hours, amounting to 21 per cent. If dry gun-cotton be placed in moist air at 100°, the resulting decomposition is found to be exactly the converse of its formation, water being gradually assimilated, with evolution of nitric acid or its elements. We refrain from entering into farther details respecting the remaining compounds until their investigation has been completed.

Inflammability.—According to Schönbein and Böttger(1), gun-cotton, when powerfully struck with a hammer, gives rise to a sharp report, the surrounding particles being scattered in every direction; the percussion, however, is not attended by actual inflammation, only the portion struck by the hammer being exploded. No inflammation takes place when gun-cotton is continuously triturated with powdered glass. The same chemists observed the deportment of gun-cotton at various temperatures, in an oil-bath.

At 130° gun-cotton did not explode,
„ 150° only after the expiration of 12 minutes,
„ 175° „ „ „ 30 seconds;
„ 200° „ „ „ 12 „
„ 230° instantaneously.

Oxland(2) concludes, from his experience of the occurrence of spontaneous combustion in drying turf, that gun-cotton is inflamed more readily before it has become perfectly dried, than after all moisture is expelled from it; he therefore performs the process of desiccation, in a current of air, at a temperature not exceeding 27° or 32°.

Practical Observations.—Lieutenant P. Weiss(3), an artillery officer, has endeavoured to determine by calculation the effect of gun-cotton, in relation to that of ordinary powder. As the author's statements are based upon the above-mentioned somewhat inaccurate analysis by Fehling, and upon the hypothesis that gunpowder, in its combustion, developes a temperature of 2000°, we refrain from following him into the details of his speculations.

(1) Loc. cit. II, 367.
(2) Chem. Gaz. 1847, 340.
(3) Dingl. Pol. J. CIII, 370.

Practical observations.

A series of comparative experiments as to the relative value of gun-cotton and gunpowder in blasting for excavations, has been made by Hall and Son(1), and particularly in a cutting through clay and sandstone, 28 feet in depth, and in which the earth was removed in layers 5 feet in thickness. These experiments show that 1 part by weight of gun-cotton is equal to 6 parts of ordinary gunpowder, so that the number of bore-holes required is reduced from six to one. The effect, however, depends, to a considerable extent, upon the compact or loose condition of the charge.

Combes(2), likewise, has continued his experiments in blasting gypsum in the quarries at Belleville, in the neighbourhood of Paris. By the observation that gun-cotton does not contain sufficient oxygen for its complete combustion, and by the fact of the gas which escapes from the crevices after explosion of a petard charged with 600 grms. being still inflammable, he has been led to assist the action of the gun-cotton with salts containing a considerable amount of oxygen.

A petard, capable of holding 3 kilogr. of blasting-powder, was charged with a mixture of 500 grms. of gun-cotton, and 400 grms. of chlorate of potassa, the latter being the theoretical quantity of chlorate required for perfect combustion. The effect produced amounted to that of a petard of 3 kilogr. of blasting, or 2·5 kilogr. of gunpowder, or of 900 grms. of pure gun-cotton. In other words, the effect of the mixture equalled that produced by the same quantity of pure gun-cotton, whilst that of an equal quantity of blasting-powder is about 3·3 less. It evolved neither vapour, smoke, nor inflammable gas. In a second experiment, Combes endeavoured to find a substitute for the expensive chlorate of potassa; for this purpose a mixture was employed consisting of gun-cotton, and 80 per cent of nitrate of potassa or 70 per cent of nitrate of soda, which are the quantities required by theory; the effect produced nearly equalled that obtained in the preceding experiment.

Bonjean's(3) ballistic experiments have proved that pyroxylin, prepared from carded cotton, cannot be replaced by a similar preparation obtained from sized or unsized paper, or from tow.

Wartmann(4) found, by his experiments with fire-arms, that the power of explosive gun-cotton is from 3 to 9 times greater than that of ordinary gunpowder.

(1) Dingl. Pol. J. CIV, 465, from Mech. Mag.
(2) Compt. Rend. XXVI, 61; Dingl. Pol. J. CVIII, 141.
(3) Compt. Rend. XXIV, 190.
(4) Arch. Ph. Nat. IV, 193.

Practical observations.

We regret that we are unable to report upon the important practical experiments upon this subject, undertaken by the Commissioners at Mayence, appointed by the former German Diet; the results of these experiments which were interrupted by the events of March have not as yet been published. But if we have been rightly informed, the experiments, made with all kinds of fire-arms, have invariably established the superiority of gun-cotton, after the great difficulty of making cartridges containing this substance so compressed as always to represent an equal charge, had been overcome.

In order to prevent the possibility of confounding gun-cotton with ordinary cotton, it has been proposed by Bonjean(1) to colour the former red by employing in the last washing a decoction of sandal-wood. Both the colour and efficacy are stated to be heightened by an addition of alum.

Explosive Mannite.—Amongst the numerous products which are formed by the action of sulphuro-nitric acid upon organic substances resembling cellulose, we have still to mention the explosive mannite, as being of some technical interest. Flores Domonte and Menard(2) obtained, on analysing this compound, from 17·1 to 17·3 per cent of carbon, from 1·8 to 1·9 of hydrogen, and from 17·0 to 17·5 of nitrogen, numbers which they have translated into the formula $C_{12}\ H_{18}\ O_7 + 5\ N\ O_5$. Explosive mannite may be obtained in a crystalline form. When gradually heated it fuses, and decomposes without explosion, but when struck with a hammer it explodes with the violence of fulminating mercury, without leaving any residue; this substance has been proposed as a cheap substitute for fulminating mercury, in the manufacture of percussion-caps.

Sobrero(3) has published an account of some very successful experiments made upon a small scale. He justly remarks that the new explosive compound is much less dangerous to prepare than fulminating mercury.

The same chemist has succeeded in preparing similarly explosive preparations from dextrin, glycerin, and cane-sugar(4).

According to Schönbein(5), cane-sugar, when treated at + 2° with sulphuro-nitric acid, is converted into a glutinous, insoluble

(1) Compt. Rend. XXIV, 22.
(2) Compt. Rend. XXIV, 89, 390; J. Pharm. [3] XII, 159.
(3) Compt. Rend. XXV, 122; Dingl. Pol. J. CV, 387.
(4) Compt. Rend. XXIV, 246.
(5) Pogg. Ann. LXX, 167; Phil. Mag. [3] XXXI, 7; Arch. Ph. Nat. IV, 20.

Explosive mannite.

mass which, after washing with water and drying at a low temperature, forms a solid and brittle substance, becoming soft and pliable when slightly warmed, and semi-fluid at a boiling temperature. When farther heated, it disengages red fumes, and explodes without leaving a residue. This substance is tasteless, inodorous, and colourless, and behaves with solvents exactly as a resin.

Lewis Thompson(1) recommends explosive sugar for various pyrotechnical purposes.

Svanberg(2) has arrived at the same result as Schönbein; he has prepared, moreover, an analogous compound from gum-arabic. This substance, which is obtained in white flakes, differs from xyloidin and explosive sugar.

(1) Pharm. J. Trans. VIII, 166; J. Pharm. [3] XIII, 103.
(2) Berzelius' Jahresber. XXVII, 389.

MINERALOGY.

Generalities. Polymeric Isomorphism.—In continuation of his former treatises upon polymeric isomorphism(1), Scheerer has published several new papers, in which he has completed the calculations of the formulæ of the various minerals in accordance with his hypothesis, and concludes with a synoptical arrangement(2). Scheerer, as is well known, assumes that 1 equiv. of magnesia, or of the isomorphous bases, may be replaced without change of form by 3 equivs. of water. Some weighty objections against this theory have been adduced by Haidinger(3), Naumann(4)—who opposed it at an earlier period(5)—Blum(6), Rammelsberg(7), and Bischof(8). These observers coincide in the opinion that aspasiolite and serpentine, the chief props of Scheerer's hypothesis, do not contain water in their original condition, and that they are not isomorphous with cordierite and chrysolite; on the contrary, they consider them as pseudomorphoses of the latter mineral. Naumann especially, has endeavoured to prove that aspasiolite stands to cordierite in the same relation as fahlunite, praseolite, chlorophyllite, bonsdorffite, and esmarkite, all of which are pseudomorphoses of

Generalities. Polymeric isomorphism.

(1) Oefversigt af K. V. Acad. Förh. III, 26 and IV, 69; Berzelius' Jahresber. XXVI, 54, 329 and XXVII, 228; Pogg. Ann. LXVIII, 319; Jahrb. Miner. 1846, 798.

(2) Pogg. Ann. LXX, 411, 545; LXXI, 285, 445.

(3) Berichte über die Mittheilungen von Freunden der Naturwissenschaften in Wien, herausgegeben von Haidinger, II, 50; Naturwissenschaftliche Abhandlungen, herausgegeben von Haidinger, I, 79; Pogg. Ann. LXXI, 266.

(4) J. Pr. Chem. XL, 1.

(5) J. Pr. Chem. XXXIX, 196.

(6) Blum's Pseudomorphosen, Nachtrag, 57.

(7) Rammelsberg's Handwörterb. 3 Suppl. 7, 20, 109; N. Jen. Lit.-Zeitung 1848, 1214.

(8) Bischof's Lehrb. der Chem. und Phys. Geologie, II, 253, 279, 384.

Generalities. Polymeric isomorphism.

cordierite, as was first assumed by Shepard(1) and Dana(2), and subsequently established by Haidinger(3), but exhibit no loss of magnesia in consequence of the assimilation of water (comp. chlorophyllite). The same mineralogist, moreover, points out that, according to Scheerer's analysis of aspasiolite, we may as well assume that 4 or even 5 equivs. of water are capable of isomorphously replacing 1 equiv. of magnesia. From the calculation of thirteen of the most accurate analyses of pure serpentine which was free from carbonic acid, Rammelsberg concludes that also in this mineral the assumption of a replacement of MgO by HO, is inadmissible. Haidinger particularly dwells upon the perfectly amorphous condition of aspasiolite, whilst an inquiry into the isomorphism of two minerals would lead us to suppose that both must be crystalline. In his ingenious reply to this and other objections, Scheerer(4) denies, in the first place, the accuracy of Naumann's re-calculation of the results he obtained in the analysis of aspasiolite, resting as it does upon as unsafe a basis as the oxygen of the alumina; he then endeavours to establish, in a more satisfactory manner, the coincidence of the crystalline forms of serpentine of Snarum, and of chrysolite, which has been doubted by Naumann. Serpentine and aspasiolite are stated to be crystalline, although in a peculiar acceptation of the term. He repeatedly asserts the original existence of water in both minerals, and now maintains that the water primarily existed also in basalt, as well as in the primitive rocks, the zeolites occurring in the latter being formed at the same period with the basalt.

Heteromerism.—Hermann, as is well known, has been led by his analysis of tourmaline to assume that this mineral occurs of three fundamental compositions, exhibiting exactly the same crystalline form, namely, as schorl, achroite, and rubellite(5). He now endeavours to establish this relation, which he terms heteromerism, in a series of other minerals(6). This class embraces the augites, hornblendes, epidotes (comp. these), monoclinometric, and triclinometric feldspars, as well as such as are represented by Scheerer as polymero-isomorphous minerals. The variable composition frequently exhibited, independently of isomorphism, by the members of this

(1) Shepard, Treatise on Mineralogy, 2nd Edit.; Sill. Am. J. [2] III, 266.
(2) Dana, Syst. of Min., 2nd Edit.
(3) Pogg. Ann. LXVII, 441.
(4) J. Pr. Chem. XLIII, 10; Pogg. Ann. LXXIII, 155.
(5) J. Pr. Chem. XXXV, 232; Rammelsb. Handwörterb. 2 Suppl. 164.
(6) J. Pr. Chem. XLIII, 35; Jahrb. Miner. 1848, 816, (in abstr.)

and other groups of minerals of the same crystalline form, Hermann explains by the assumption that they contain two or more heteromeric terms, either separate or crystallized together. According to his view, all bodies possessing a similar crystalline form, dissimilar though the nature, number, and grouping of their atoms may be, are capable of crystallizing together (NaO, NO_5; CaO, CO_2), like isomorphous substances, provided they are endowed with the requisite degree of mutual molecular attraction. The latter circumstance being of rather rare occurrence, heteromeric compounds are less frequently found in nature than isomorphous bodies, and have not hitherto been artificially prepared. They appear to separate most frequently from masses in a state of igneous fusion, the crystals being compelled, as it were, in the absence of normal molecules, to assimilate isomorphous or heteromeric atoms. Heteromerism.

Rammelsberg(1), on inquiring more minutely into the cases of heteromerism adduced by Hermann, has found some of them to be based upon doubtful formulæ, others to be sufficiently explained by the equality or proportionality of the atomic volumes; therefore he considers the adoption of a new hypothesis to be unnecessary.

Definition of Species of Minerals.—Kobell and Fuchs have discussed the question, how far the isomorphous constituents are to be considered in defining the species of minerals. Kobell(2) regards the so-called boundary-terms and middle-terms, as true species. Boundary terms are "compounds of similar composition, and crystallization when occurring with one base (CaO, CO_2; MgO, CO_2), or in the case of two compounds of dissimilar nature being present, when each of these compounds contains only one base," ($3\,FeO, SiO_3 + Al_2O_3, SiO_3$; $3\,CaO, SiO_3 + Al_2O_3, SiO_3$). A series of boundary-terms constitutes the true mineralogical genus, or, to use the term of Fuchs, the orictognostic formation.—Middle-terms are compounds of boundary-terms in equal equivalents, being distinguished by certain constant characters, such as distribution, angle of cleavage, chemical properties, &c. It appears, moreover, that compounds of the form, $2\,A + 3\,B$; $3\,B + 2\,C$, &c., as well as combinations of middle-terms with each other, are met with; and that they may be regarded as species.—In examining a mineral, in the first place the boundary-terms A, B, &c. are calculated from the analysis, and from these the middle-terms A + B, &c. If an excess remains, the mineral is assigned to the prevailing species, and described as a variety mixed with A, B, or A + B, the admixture being represented in the formula by small

(1) N. Jen. Lit.-Ztg. 1848, 1214. (2) J. Pr. Chem. XLIV, 99.

Definition of species of minerals.

letters, f. i. garnet of Ohlápian (3 MgO, SiO_3 + Al_2O_3, SiO_3) + (3 FeO, SiO_3 + Al_2O_3, SiO_3), with an excess of clay-iron-garnet = 3 (MgO, FeO, feo), SiO_3 + Al_2O_3, SiO_3.

Fuchs(1) considers only the boundary-terms as species, inasmuch as the admission of middle- and intermediate-terms would establish a transition of one species into another, thus violating the leading principle of every doctrine in natural science, *"that each species forms a perfect and distinct whole."* He considers the middle and intermediate terms as species which have crystallized together, their integrant molecules being compelled, as it were, by the force of crystallization, to an equal distribution, and to a parallel position. Mutual substitution (*vikariren*) of the constituents in the acceptation of the term, as hitherto adopted and unfortunately introduced by himself, is no longer admissible. On the other hand, Fuchs now defines formation *"as the whole of those species which, having a similar chemical constitution, and a similar or essentially similar crystalline form, are capable of uniting in all proportions, without change in the form of crystallization."* The term substitution, formerly used in the case of species, has now, when applied to formations, to be replaced by the expression, alternation.

Mineralogical System of Naumann.—Naumann(2) denies that in establishing his so-called mixed system he has had the intention, as erroneously intimated by Berzelius(3), to propose a new mineralogical system. He believes that a natural system, methodically arranged, and satisfying the claims of science in a rigid manner, cannot possibly be constructed before the intimate connection between physical and chemical properties has been farther elaborated; on this account, he had used the expressions "synoptical arrangement of the species, or of minerals, in groups and series." The term "mixed system," was intended to convey his opinion that the similarity should be traced *simultaneously* in the chemical, as well as in the physical properties; this term advocated by no means two principles of classification, but only *one*, namely, the *principle of general natural similarity*.

New Mineralogical System of Berzelius.—Rammelsberg(4) has constructed a purely chemical system of mineralogy, according to the principles which Berzelius had propounded when criticising Nau-

(1) J. Pr. Chem. XLV, 1.
(2) J. Pr. Chem. XL, 321.
(3) Berzelius' Jahresber. XXVI, 294.
(4) Berzelius' neues Chem. Mineralsystem, herausgeg. von Rammelsberg, Nürnberg 1847; Pogg. Ann. LXXI, 477.

mann's mixed system. The limits of this Report will not admit of following the author in detail through his treatise which he modestly terms an essay.

New mineralogical system of Berzelius.

Metalloids. Diamond.—In the gold-washings of Twitty's mine, in the itacolumite-region of Rutherford County, North Carolina, a transparent diamond has been found, weighing 4·12 grains. It is now in the possession of Mr. Shepard, who had anticipated the existence of diamonds from the occurrence of itacolumite, which he had discovered in that locality(1).

Respecting the comportment of diamonds at high temperatures, comp. Vol. I, p. 253.

Metals. Platinum.—Native platinum has been found amongst the wash-gold, obtained from the mines in the possession of Mr. Erwin, in the County of Rutherford. Ch. U. Shepard(2) obtained from this locality a kidney-shaped bead, of a spec. grav. = 18, and weighing 2·541 grains.—Platinum, together with native iron containing nickel, is said by Molnár to occur also in the gold-sand of Ohlápian, in Hungary(3). Kopetzky and Patera, however, on a more minute examination, did not find any platinum(4), nor did they meet with any nickel in the iron, hence they believe that it was derived from the tools of the workmen. Molnár(5), however, on repeating his experiments, extracted 34 grains of small crystals of magnetic iron-ore containing platinum, and from which he prepared the double salt of bichloride of platinum and chloride of ammonium. He insists, likewise, on his statement respecting the presence of nickel in the iron.

Gold.—In August, 1847, Professor Ulrich, of Zurich, found native gold disseminated in gabbro, on the heights of the Saasgrat, 11,000 feet above the level of the sea, between the Saas- and Zermat-valleys(6).—As yet the scientific journals have not communicated any details respecting the districts of California, represented to be so fabulously rich in gold by the daily papers. A specimen of wash-gold from California, presented by Peabody to the *Ecole des Mines*, in Paris, consisted of small, beautiful, golden-yellow plates, together with a roundish bead, weighing 0·628 grm., the plates being mixed with small grains of titanic-iron which could be

(1) Sill. Am. J. [2] II, 253 ; Pogg. Ann. LXX, 544, (in abstr.)
(2) Sill. Am. J. [2] IV, 280; J. Pr. Chem. XLV, 454, (in abstr.)
(3) Haidinger's Berichte (comp. II, 379) III, 412.
(4) Haidinger's Berichte III, 439.
(5) Haidinger's Berichte III, 475.
(6) Jahrb. Miner. 1848, 522.

Gold.

extracted by the magnet.—The percentage-composition of the plates was found to be 90·70 gold, 8·80 silver, and 0·38 iron(1).—In the year 1847, the produce of wash-gold in Russia was 1780·943 *pud* = 29835 kilogrammes: namely, from the Ural 324·628 *pud*, from Nertschinsk 25 *pud*, and from East and West Siberia 1431·315 *pud*. The produce of gold from the Altai, and from the silver mines of Nertschinsk, was 45 *pud*(2).

Gold-Amalgam.—Schneider(3) has examined, in Marchand's laboratory, an amalgam of gold, which was found in a platinum-ore from Columbia, in which it occurred in the form of readily compressible balls of the size of peas. It consisted of 57·40 per cent of mercury, 38·39 of gold, and 5·0 of silver; formula, $Hg_{12}\left\{\begin{matrix}Au\\Ag\end{matrix}\right\}_5$.

Bismuth-Gold.—Amongst the wash-gold from the mines of Mr. Erwin, in the County of Rutherford, North America, Willis has met with small grains, of the colour of palladium, which, on qualitative examination by C. U. Shepard(4), were found to consist of bismuth-gold, with a portion of adhering mercury. Spec. grav. from 12·4 to 12·9; hardness = 2·5 to 3, the grains being malleable, and finally brittle; structure? (fracture) of a hackly appearance. Before the blow-pipe they formed readily fusible balls, which became crystalline on cooling. By the continuous action of the blow-pipe-flame, white vapours and a yellow incrustation were produced, together with a bead of gold, of about half the size of the specimen operated upon. Shepard considered this alloy as a smelting product, whilst Gibbon and Clingman regard it as a natural substance, since bismuth is frequently found in the southern States of North America.

Copper.—Forrest Shepherd has published an account of a large boulder-mass of native copper(5), now in his own collection, and found in July, 1845, upon the southern shore of Lake Superior at a short distance from the Elm river. It is $3\frac{1}{2}$ feet long, $2\frac{1}{2}$ feet broad, and from 7 to 8 inches thick; it weighs 1625 pounds and exhibits on its surface minute spots of native silver, whilst in some of the cavities syenite and sandstone are perceptible. It probably came from a ridge of stratified green-stone, situated 8 or 9 miles to the south wherein native copper is found which is likewise dotted

(1) Ann. des Mines [4] XIV, 105.
(2) Ermann's Archiv. für wissenschaftl. Kunde von Russland, 1848.
(3) J. Pr. Chem. XLIII, 317.
(4) Sill. Am. J. [2] IV, 280.
(5) Sill. Am. J. [2] IV, 115.

with silver. Some time previously a boulder of native copper was found near Lake Superior, weighing 2200 pounds(1). Copper.

Rhodius(2) has given an explanation of the process of formation of the beautiful native copper which is found in paper-like plates in the decomposed basalt of Rheinbreitbach. The disintegration of purple copper pyrites, in a vein of quartz traversing this basalt, gave rise to the formation of sulphate of copper. The solution of this salt, when percolating the basalt, was decomposed by the lime, magnesia and alkali, present in the rock, the oxide separated being reduced by the organic matter of the atmospheric waters. In this manner the basalt lost the total amount of its lime and alkali, and the olivine of the basalt half its magnesia and protoxide of iron. The drainage water in the mines contains both lime and magnesia in the form of sulphates.

Tellurides. Foliated Ore of Tellurium. — According to Jackson(3), the hitherto but rarely occurring foliated tellurium is found in considerable quantity upon a newly-discovered auriferous vein in the mica-slate at Whitehall, near Friedricksburg in Virginia. Until it came into the hands of Jackson, it was regarded as molybdenite, and consequently neglected.

Tetradymite.—Hruschauer(4) has found the composition of tetradymite from Schubkau to agree with that resulting from the analyses of Berzelius and Wehrle; this mineral contains:

Bi	Te	S	Total
59·2	35·8	4·6	99·6

Arsenides. Smaltine.—Under the direction of Genth, Sartorius(5) has analysed a kind of smaltine (speisscobalt) from Richelsdorf distinguished by the large amount of nickel it contained (crystals an inch in size of ∞ O ∞ . O . ∞ O). After deducting 0·94 per cent of sulphur, and 0·82 of iron, which were considered to be present as an admixture of iron pyrites, analysis gave:

Ni	Co	Fe	As	Total
14·06	9·17	1·42	73·53	98·18

(1) Sill. Am. J. [2] III, 2.
(2) Ann. Ch. Pharm. LXIII, 212.
(3) Sill. Am. J. [2] VI, 188.
(4) Bericht über die 21 Versammlung deutscher Naturforscher, 195; J. Pr. Chem XLV, 456.
(5) Ann. Ch. Pharm. LXVI, 278.

Cobaltine.

Cobaltine. (Cobalt-glance.)—Schnabel(1) has analysed the cobaltine-dust (*Kobaltschliech*) from the mine Philippshoffnung, near Siegen (I), consisting of microscopically small, but distinct crystals; Hubert(2) the compact cobaltine from Orawitcza in Upper Hungary (II); and Patera a fibrous variety from the same locality (III). The two latter contain gold, and native bismuth; the latter metal amounts to 18 per cent and may be worked off. The analyses agree with the well known formula proposed by Berzelius, $Co\,As + (Co\,Fe)\,S_2$:

	Co	Fe	As	S	Total
I.	29·77	6·38	44·75	19·10	100·0
II.	30·37	5·75	44·13	19·75	100·0
III.	32·02	4·56	43·63	19·79	100·0
Calculation.	35·54	—	45·18	19·28	100·0

(Nickel-glance). — Löwe(3) has analysed crystallized arsenical nickel-glance from Schladming in Styria (I), and a compact variety from Brakendorf in Upper Hungary (II).

	Ni	Fe	As	S	Total
I.	26·14	9·55	49·83	14·13	99·65
II.	28·75	8·90	46·10	16·25	100·00

From the former of these analyses, already known from a private communication sent by Löwe(4) to Rammelsberg, the author deduces the formula $Fe\,S_2$, $Ni\,S + 2\,Ni\,As$; he considers the mineral as a new species (Gersdorffite). Rammelsberg(5) justly rejects this formula which is not constructed according to binary principles, and contains two isomorphous metals in two states of sulphuration; moreover the calculated percentage agrees not with the result of analysis. He points out(6) that the above, as well as Kobell's analyses exhibit an excess of Ni and As very nearly in the proportion of $Ni_2\,As$, when compared with the composition assumed by Berzelius; hence he believes it to be probable that many kinds of nickel-glance contain an isomorphous admixture of the compound $Ni_2\,As$ which may be assumed with some degree of certainty to crystallize in the regular system.

(1) Osterprogramm 1847 der Realschule zu Siegen; Pogg. Ann. LXXI, 516; Rammelsberg's Handwörterb. 3 Suppl. 65.

(2) Haidinger's Berichte (comp. II, p. 379) III, 389.

(3) Haidinger's Berichte II, 82; Haidinger's Abhandl. I, 343.

(4) Rammelsberg's Handwörterb. 2 Suppl. 102.

(5) Rammelsb. Handwörterb. 3 Suppl. 89.

(6) N. Jen. Allg. Lit.-Ztg. 1848, 854.

Sulphides. Bismuthine (Bismuth-glance).—A specimen of compact bismuthine from Orawitza in Upper Hungary contains, according to Hubert's(1) analysis:

S	Bi	Cu	Pb	Fe	Au	Total
19·46	74·55	3·13	2·26	0·40	0·53	100·35

After deducting 1·59 of S required for the galena, chalkosine (copper-glance), and iron pyrites which are mixed with it, it yields 80·73 Bi and 19·26 S = Bi S_3.

Magnetic Iron-Pyrites.—G. Rose(2) has pointed out that magnetic pyrites cannot be Fe S, but must be considered, in accordance with Berzelius' view, as a compound of Fe S and Fe_2 S_3. As Stromeyer first demonstrated, all the varieties of magnetic iron-pyrites, when dissolved in hydrochloric acid, leave behind an excess of sulphur which neither existed in the free state nor in the form of iron-pyrites, inasmuch as pure magnetic pyrites, on solution, leaves not a trace of the latter behind, and yields no sulphur when treated with bisulphide of carbon. Rammelsberg(3) adduces by way of confirmation, that magnetic iron-pyrites when ignited in hydrogen give off the same amount of sulphur which is left behind by dissolving in hydrochloric acid. Magnetic iron-pyrites is invariably magnetic, which is not the case with carefully prepared, artificial Fe S. The specific gravity of magnetic iron-pyrites is far lower than that of iron-pyrites, whilst it should be the reverse. The analogy of the crystalline form with that of various metallic monosulphides and antimonides, by which Breithaupt had been led to assume the composition Fe S, is not of sufficient weight, since it is known that bodies of dissimilar atomic composition are capable of affecting similar forms.—Rose considers the formula 5 Fe S + Fe_2 S_3 to be the only correct one. The variations in the analyses of pure magnetic iron-pyrites, are not sufficiently great to warrant the assumption of two other species (Fe S + Fe_2 S_3 and 9 Fe S + Fe_2 S_3), these trifling oscillations depending upon the presence of sesquioxide of iron occurring between the planes of the crystals.

Hauerite.—Haidinger(4) has described a new mineral belonging to the blendes, and to which he has assigned the name hauerite. It was discovered by Adler at Kalinga, near Neusohl in Hungary,

(1) Oestr. Blätter für Literatur, 1847, 1133; Haidinger's Berichte (comp. II, p. 379), III, 401.
(2) Pogg. Ann. LXXIV, 219.
(3) N. Jen. Lit.-Ztg. 1848, 851.
(4) Haidinger's Berichte, II, 2; Haidinger's Abhandl. I, 101.

Hauerite. where it occurs imbedded in clay, gypsum, and sulphur, forming splendid and often very large crystals of the tesseral system, or spherical groups with a radio-fibrous structure, similar to that of many kinds of iron-pyrites; cleavage very perfect in the direction of $\infty O \infty$; hardness=4; spec. grav.=3·463 (Hauer). Colour from reddish-brown to brownish-black; streak brownish-red. In thin splinters it is transparent, and of a brownish-red colour. It has sometimes an imperfectly metallic, and occasionally a metallic adamantine lustre.—Heated in a flask it yields sulphur, and leaves green sulphide of manganese MnS; heated on charcoal before the blow-pipe, it gives a sulphur-flame, and after the separation of the whole of the sulphur, exhibits, with phosphorus-salt, the reactions of manganese.

According to the analysis of Patera(1), the composition of this mineral is:

Calculated.		Found.			
Mn	46·28	42·97	=	45·198	After deducting the silicic acid and iron present in the form of iron-pyrites.
2S	53·72	53·64		54·802	
Fe	„	1·30		„	
SiO_3	„	1·20		„	

Cinnabar.—A new and highly productive mine of cinnabar has been opened in Upper California. Lyman(2), who has visited the neighbourhood, has given some information respecting this mine in a letter written on the 24th of May, 1848. New Almaden lies between San Francisco and Monterey, near the coast; it is 1200 feet above the plain, and situated upon a ridge of the Sierra Azul which consists of a greenish talc-rock. The cinnabar is found in nests, in a stratum of a yellowish earth, which is 42 feet in thickness. The occurrence of this mineral has been known to the natives from time immemorial as the cave of red earth, which they employed for painting their bodies. During Lyman's presence, the daily produce from 1600 pounds of cinnabar, distilled in a rudely constructed apparatus, was from 200 to 300 pounds of mercury, and in the last three weeks the total amount obtained was about 10,000 pounds. Cinnabar has likewise been found in fifteen or twenty other places, within a circumference of a few miles.

Needle-Ore.—Chapman(3) has analysed needle-ore, from Ekatherinenburg, in Siberia. It consisted of thin prismatic needles, resting

(1) Haidinger's Abhandl. (compare II, p. 379) I, 107; Haiding. Berichte II, 18; Pogg. Ann. LXX, 148, (in abstr.)

(2) Sill. Am. J. [2] VI, 270.

(3) Chem. Gaz. 1847, 337.

upon quartz, and accompanied by malachite. Hardness = 2·0 to 2·5; spec. grav. = 6·1. Needle-ore.

	S	Bi	Pb	Cu	Total
I.	18·89	28·04	40·43	12·64	100·00
II.	16·56	36·73	35·77	10·94	100·00

Chapman has deduced, from the numbers obtained, the recognized formula 3 Cu_2 S, Bi S_3 + 2 (3 Pb S, Bi S_3), corresponding to that of bournonite; this formula requires, however, as a theoretical percentage, the numbers given under II. S, Pb and Cu certainly stand in the correct proportion, but the amount of Bi obtained is $\frac{1}{3}$rd too little. A correction is quite inadmissible, since it would lead to an excess of 12·8 per cent, nor can any other formula of greater probability be calculated from these numbers.

Jamesonite.—Löwe(1) has analysed a specimen of jamesonite from a new locality, namely, Arany-Idka in Upper Hungary. Spec. grav. = 5·601. It readily fuses on charcoal before the blow-pipe, forming an incrustation of protoxide of lead and antimonic acid.

S	Sb	Pb	Cu	Ag	Fe	Zn	Bi	Matrix.	Total.
18·069	32·168	39·668	1·729	1·440	2·909	0·339	0·214	2·815	99·351

From these results Löwe has calculated the formula 2 (Pb S, Sb S_3) + Pb S which in fact agrees perfectly well with the numbers found for S, Sb and Pb; there remains, however, no S for the other metals which require 4·188 per cent of this element.

Feather-Ore.—Poselger(2) has analysed, in Rammelsberg's laboratory, a compact mineral, of the spec. grav. 5·6788, found by Zincken in the antimony-mine near Wolfsberg. It had the composition of feather-ore.

Pb	Sb	S	Total
48·48	32·98	20·32	101·78

Berthierite.—Pettko(3) has analysed berthierite from Arany-Idka in Upper Hungary. Spec. grav. = 4·043. Soluble in hydrochloric acid, with evolution of hydrosulphuric acid, but without separation of sulphur. It has the composition of a similar mineral from Anglar, analysed by Berthier:

FeS + SbS_3	S	Sb	Fe	Total
Found . .	29·270	57·882	12·848	100·0
Calculated .	28·950	58·380	12·670	100·0

(1) Haidinger's Berichte (comp. II. 379) I, 62.
(2) Rammelsb. Handw. 3 Suppl. 44.
(3) Haidinger's Berichte, I, 62.

Fahl-ore.

Fahl-Ore.—Volger(1) has endeavoured to prove that the beautiful coatings of copper-pyrites, which have been found upon the black fahl-ore from the Rosenhöferzug, near Clausthal, are not merely incrustations, but pseudomorphoses of that substance.

Sachsenheim(2) has observed, in fahl-ore from the Hartz, the hitherto unknown hexakisoctahedron $\frac{2}{5}$ O $\frac{1}{3}$ in subordinate combination.

Anhydrous Oxides. Red Zinc-Ore.—Whitney(3) has analysed coarse-grained zinc-ore, occurring in franklinite, and obtained from the Franklin smelting-house (I); and also the foliated variety from Sterling (II), associated with foliated magnetic iron.

	ZnO	Mn_2O_3	Undecomposed mineral.	Loss on ignition.	Total.
I.	94·45	traces	4·49	1·09	100·03
II.	96·19	3·70	0·10	„	99·99

Hence it appears that the larger proportion of manganese found by Berthier and Bruce is unessential. The powder of red zinc-ore from the Franklin smelting-house is stated to dissolve, after ignition, in sulphuric acid with a deep red colour.

Minium.—Noeggerath(4) obtained from Zwirner, architect of the Cologne Cathedral, a piece of lead with which some iron clamps had been fastened into the edifice, and which by the long continued influence of the atmosphere had become coated with a thin layer of minium, principally, however, on those parts which had been in contact with the stone (trachyte, from the Drachenfels.)

Pitchblende.—Respecting this mineral, comp. II. 396.

Arkansite.—Shepard(5) has completed his earlier(6) description of arkansite which was discovered by Powell at Magnet Cove, in North America. The small, indistinctly reflecting crystals are combinations of a rhombic octahedron with $\infty\breve{P}x$. $\infty\bar{P}\infty$ and $x\breve{P}\infty$, the former prism with angles of from 101° to 101° 15′, the latter of 123°. Spec. grav. = 3·854. In his former communication, Shepard had affirmed that titanic acid and yttria were constituents of arkansite; after repeating the qualitative examination, he states that the acid was niobic acid. Recent investigations which will be com-

(1) Pogg. Ann. LXXIV, 25.
(2) Haidinger's Berichte (comp. II. 379), IV, 431.
(3) Pogg. Ann. LXXI, 169.
(4) Jahrb. Miner. 1847, 1 Heft.
(5) Sill. Am. J. [2] IV, 279.
(6) Sill. Am. J. [2] II, 250.

municated in our Report for 1849, have pointed out that arkansite is a variety of brookite. Pyrolusite

Pyrolusite.—Riegel(1)has investigated a specimen of splendidly crystallized manganese-ore from Krettnich:

	MnO, Mn_2O_3	O	CuO	Fe_2O_3	HO	Insol. matter	Total
I.	84·40	11·50	trace	0·54	1·10	2·06	99·60
II.	86·00	11·65	trace	0·40	1·40	0·71	100·16

According to Völcker(2) manganese-ore frequently contains cobalt; the presence, however, of this metal, as well as of nickel, had at an earlier period been established by Gregory.(3)

Titanic-Iron.—Rhodius(4) has analysed slaggy magnetic iron-ore from the basalt of the Virneberg, near Rheinbreitbach (spec. grav. =5·1), and has found its composition to be similar to that of the same mineral occurring at Unkel and analysed by Rammelsberg(5).

Fe	O	TiO_2	Total
65·87	24·50	9·63	100·00

If, with Rose and Scheerer, we assume the titanium to be in the form of sesquioxide, the preceding numbers lead to the formula $(6\,FeO, Fe_2O_3) + (4\,Ti_2O_3, 5\,Fe_2O_3)$, according to which the mineral is a mixture of magnetic- and titanic-iron of a composition similar to that from Ilmensee.

Emery.—Tchihatscheff(6) has discovered a new and very considerable source of emery in Asia Minor. The mineral is found in large blocks upon disintegrated lime-stone, which occurs in the mountain-passes between the village Eskihissar (Stratonicea of the ancients), and the Lake Akistschai (Latmus). In still larger quantity it is met with upon the slopes of the Gummugdagh (mons Thorax), Almandagh and the Samsundagh (Mykale). It is stated, moreover, that emery has been recently found in Samos.

Quartz.—By rapidly heating or cooling rock-crystal, Kenngott(7) obtained more distinct planes of cleavage than have been hitherto observed. They are in the direction both of R and —R, and occasion upon ∞P a net-like delineation whose lines are parallel to the combination-edges of a predominating plane R with the lateral planes ∞P. One crystal only exhibited a plane of cleavage solely in the

(1) Jahrb. Pr. Pharm. XVI, 319; J. Pr. Chem. XLV, 455.
(2) Ann. Ch. Pharm. LIX, 27.
(3) Ann. Ch. Pharm. LXIII, 277.
(4) Ann. Ch. Pharm. LXIII, 219.
(5) Rammelsb. Handw. 1 Suppl. 144.
(6) Compt. Rend. XXVI, 363.
(7) Pogg. Ann. LXXIII, 603.

Quartz.

direction of R. Several crystals, when heated to redness and plunged into cold water, assumed in the interior a fibrous appearance and satiny lustre, the fibres being inclined towards the axis in such a manner that the transverse fracture presented on the one side a cone, and on the other a corresponding cavity.

Calcedony.—Rennenkampf(1) believes to have recognized, in about two hundred specimens of the moss-agates, dendrites and mocha-stones, which had been collected on the Hundsrück, impressions of certain kinds of mnium tremella, with sporules, cladonium, &c. They appear, with their ramifications, to have penetrated through the deposited strata of the mass of calcedony, whilst dendritic formations are found only between these strata, and upon the crevices. Göppert(2), on the other hand, is of opinion that actual inclosures of plants do not exist in calcedony.

Hydrated Oxides. Hyalite.—In continuing his earlier experiments(3), Ebelmen has obtained, by very slow decomposition of an alcoholic solution of silicic ether in moist air, perfectly pure and transparent masses of artificial hyalite and hydrophane of considerable size(4). By adding to the ether alcoholic solution of colouring matters, coloured hyalites were obtained, while the addition of terchloride of gold gave rise to the formation of topaz-yellow masses, in which delicate plates of gold were separated under the influence of reflected solar light, imparting to the product the appearance of the finest specimens of aventurine.

Noble Opal.—Pulsky(5) has communicated more accurate details respecting the occurrence and collection of noble opal, near Kaschau. The oldest opal-mines probably are the so-called fifty graves, which are numerous filled-up shafts in a valley near Czerwenitza. The mines which are at present worked are situated upon the Simonka- and Libanka-mountains, where the opal occurs in veins and in cavities in the trachyte. If the cavities are not completely filled the mineral exhibits an horizontal surface, and likewise horizontal planes of stratification, which is a proof, that originally it had been in a fluid state. The opal, as obtained, contains many crevices, or acquires them in a short time.

Silicious Sinter.—Salvetat(6) has investigated silicious sinter

(1) Jahrb. Miner. 1847, 26.
(2) Flora 1848, 29; Jahrb. Miner. 1848, 750, (in abstr.)
(3) Ann. Ch. Phys. [3] XVI, 129; Berzelius' Jahresber. XXV, 754, (in abstr.)
(4) Compt. Rend. XXV, 855.
(5) Haidinger's Berichte (comp. II, 379), III, 213; Jahrb. Miner. 1848, 828.
(6) Ann. Ch. Phys. [3] XXIV, 348.

Silicious sinter.

obtained from the neighbourhood of Algiers. It contained 9 per cent of water, and yielded to solution of potassa 80 per cent of amorphous silicic acid. The argillaceous residue consisted of 6·48 per cent of SiO_3, 1·41 Al_2O_3, 0·55 Fe_2O_3, 0·56 CaO, 2·0 MgO, KO and NaO. —Salvetat terms this substance randanite, on account of its similarity to that which is obtained from Randan and Ceyssat. The silicic acid he believes to be present in the form of a hydrate of definite composition $= HO, 2\,SiO_3$ when dried at 16°, and $HO, 4\,SiO_3$ at 100°; this cannot, however, be proved on account of the 11 per cent of clay which is mixed with the mineral.

Diaspore.—Marignac(1) has found small but very distinctly formed crystals of diaspore with reflecting planes, upon red corundum in the granular dolomite from St. Gotthard; and, by the measurement of these crystals, has confirmed the statement of Haidinger(2), that diaspore belongs to the rhombic system of crystallization. The crystal submitted to measurement, exhibited, similar to topaz, a combination of $\infty P . \infty \breve{P}3 . \infty \breve{P}4 . \infty \breve{P}\infty . P . 2\breve{P}2 . 2\breve{P}\infty$. Some of the principal angles measured are the following:

P = 151° 36′ in the brach. princ. sec. 116° 38′ in the macrod. p. sec. — in the basc.

$2\breve{P}2$	= 126° 12′	„	„	„	122° 15′,	„	„	97° 0′	„	„
2 P	= 130° 0′	„	„	„	—	„	„	—	„	„
$\infty\breve{P}\infty$	= 117° 46′	„	„	„	—	„	„	—	„	„

From the two last it follows that principal axis : macrodiagonal : brachydiagonal = 0·3018 : 1 : 0·4680. Cleaveable in the direction of $\infty \breve{P} \infty$. Streaked upon ∞ P.

Hydrargillite.—Hermann(3) has analysed hydrargillite from Schischimskaja-Gora (Slatoust)(4), which he obtained of a translucent and nacreous appearance by digestion with hydrochloric acid. Spec. grav. = 2·387. After deducting a portion of sulphate of alumina it gave the composition which has hitherto been ascribed to gibbsite (comp. the latter), namely $Al_2O_3 + 3\,HO$(I). According to Kobell(5) a mineral from Villa Ricca, in Brazil (II), which has hitherto been considered as wavellite, also has a similar composition.

	Al_2O_3	HO	PO_5	Total
I.	64·03	34·54	1·43	100·00
II.	65·6	34·4	„	100·00*
Calculation.	65·56	34·44	„	100·00

* Besides traces of Fe_2O_3 and SO_3.

(1) Arch. Ph. Nat. VI, 296.
(2) Pogg. Ann. LXI, 307.
(3) J. Pr. Chem. XL, 2.
(4) G. Rose, Reise nach dem Ural II, 122; Pogg. Ann. XLVIII, 564.
(5) J. Pr. Chem. XLI, 152; Jahrb. Miner. 1848, 705.

Granular iron-ore.

Granular Iron-Ore.—Delesse(1) has examined the magnetic mineral from St. Brieux (Côtes du Nord), which is somewhat similar to granular iron-ore, and was formerly investigated by Berthier(2). Spec. grav. =3·988. Composition :

SiO_3	Al_2O_3	Cr_2O_3	Fe_2O_3	FeO	CaO	HO	Carbon	Clay	Total
6·50	7·50	0·50	65·45	13·25	0·45	4·85	1·30	0·20	100·00

Manganates. Crednerite.—A new cupreous manganese-ore(3), occurring together with volborthite (see the latter), has been found at Friedrichsrode, by Credner who has communicated an analysis(4) of this mineral which has been likewise analysed by Rammelsberg(5), who proposed to call it crednerite.—It occurs in the form of foliaceous, or granular masses, in psilomelane or hausmannite. It exhibits three directions of cleavage, which correspond to an oblique rhombic prism; in the most perfectly developed direction (0 P ?), it shows a bright metallic lustre, and rhombic striæ. Somewhat brittle, fracture uneven; hardness from 4·5 to 5; spec. grav. from 4·89 to 5·07 (Credner), 4·95 to 4·97 (Rammelsberg). Colour opaque iron-black; streak black, inclining to brown. Thin splinters only are fusible at the edges. When fused with soda on charcoal, it gives a ductile copper bead, and yields chlorine by treatment with hydrochloric acid; this gas is, however, no longer evolved after the mineral has been ignited in hydrogen, whereby it loses in weight from 13·5 to 13·58 per cent (Rammelsberg).

		CuO	MnO	CaO	BaO	Mn_2O_3	O	HO	Residue	Total
Credner	1.	43·85	—	—	—	55·73	—	—	—	99·58
	2.	42·13	22·96	0·63	0·52	31·25	—	0·25	0·63	98·35
Rammelsberg	1.	23·73	64·24	—	2·01	—	8·83	—	—	98·81
	2.	32·35	56·29	0·76	3·08	—	8·58	—	—	99·06
	3.	34·65	54·72	—	2·71	—	6·51	—	—	98·59
	4.	40·02	51·69	—	1·04	—	—	—	—	—
	5.	40·65	52·55	—	1·48	—	5·78	—	—	100·46

All the specimens analysed contained traces of VO_3.—Credner proposes the formula 4 (CuO, MnO), Mn_2O_3, which is analogous to that of volborthite; Rammelsberg, however, adopts the formula 3 (CuO, BaO), 2 Mn_2O_3, since a sufficient amount of oxygen is present to admit of assuming the whole of the Mn to be in the form of Mn_2,O_3; the latter formula requires 51·39 MnO, and 5·76 oxygen, agreeing with the two last determinations for which the purest and freshest specimens had been employed.

(Spinels.) Ferrates.—Respecting the artificial production of

(1) Ann. des Mines [4] XIV, 69.
(2) Essais par la voie sèche II, 248.
(3) Jahrb. Miner. 1847, 5.
(4) and (5) Pogg. Ann. LXXIV, 546.

minerals of the spinel-series, comp. I, 17; respecting a new hexakisoctahedron exhibited by magnetic-iron, comp. I, 18. Magnetic-iron.

Magnetic Iron.—Genth(1) has investigated the so-called "iron-mulm" which is found at the Alte Birke mine, near Siegen, in the neighbourhood of a basaltic eruption through siderose containing a large quantity of manganese.—Black, soiling; strongly attracted by the magnet. Spec. grav. = 3·76.

	Fe_2O_3	FeO	MnO	Sand	Total
1.	66·71	—	17·11	1·34	—
2.	—	13·65	17·62	1·57	—
3.	65·68	14·09	16·25	2·34	98·36

Besides traces of Co, Cu, CO_2 and HO.—This mineral is, therefore, earthy magnetic iron in which upwards of half the FeO is replaced by MnO. It is evidently formed by the action of the basalt upon the siderose (comp. II, 338.)

Aluminates. Chrome-Iron. — Moberg(2) believes that in chrome-iron and pyrope chromium is not present in the form of the sesquioxide, since these minerals do not exhibit the colour of this oxide. Berthier's, Laugier's, Seybert's, and Abich's analyses, moreover, do not agree very accurately with the ratio of oxygen of $RO : R_2O_3 = 1 : 3$. He has, therefore, analysed a slightly magnetic chrome-iron from Beresow (I), which had been previously digested with hydrochloric acid, and believes to have confirmed his view by arriving at the ratio 1 : 3·727 which leads to the numbers given under II, (equiv. of Cr = 26·78).

	Cr_2O_3	Al_2O_3	CrO	FeO	MgO	SiO_3	Total
I.	64·17	10·83	—	18·42	6·68	0·91	101·01
II.	58·40	10·83	5·17	18·42	6·68	9·91	100·41

Comp. I, 316, of this Report.

Kreittonite.—Kobell(3) has analysed the spinel which he found at Bodenmais, and to which Breithaupt(4) assigned the name "*Spinellus superior.*" By deducting 10 per cent of undecomposed residue, and calculating the protoxide of iron which was not directly determined, its composition was found to be:

Al_2O_3	Fe_2O_3	FeO	ZnO	MnO	MgO	Total
49·73	8·70	8·04	26·72	1·45	3·41	98·5

Conformably to his views regarding mineral species containing isomorphous constituents (comp. II, 381), Kobell considers this mineral to be a new intermediate term of the spinel-group, composed of pleonaste, and a middle-term constituted like franklinite,

(1) Ann. Ch. Pharm. LXVI, 270.
(2) J. Pr. Chem. XLIII, 114.
(3) J. Pr. Chem. XLIV, 99.
(4) Breithaupt, Handb. der Min. III, 623.

Coracite. Pitch-blende.

the latter constituent predominating ($MgO, Al_2O_3 + FeO, Al_2O_3$) + ($ZnO, Al_2O_3 + FeO, Fe_2O_3$. In place of the inconvenient scarcely mineralogical name given by Breithaupt, Kobell proposes the term kreittonite in reference to its high spec. grav. (4·49).

Coracite. Pitch-blende.—Le Conte(1) applies the name coracite to a mineral found by Stannard on the north shore of Lake Superior, where it occurs at the junction of trap and syenite, the veins in which it is found being about 2 inches in width. Perfectly amorphous, with an uneven conchoidal fracture and resinous lustre. Colour black, streak grey; hardness = 4·5; spec. grav. = 4·378. When exposed alone to the blow-pipe-flame it remains unaltered, but exhibits the reactions of uranium when treated with fluxes. It readily dissolves in hydrochloric acid to a yellowish-green solution. It was not examined quantitatively, in consequence of being traversed in all directions by minute fissures filled with carbonate of lime, magnetic iron and silica; a qualitative examination, however, having pointed out the presence chiefly of protoxide of uranium and alumina, besides some thoria, probably derived from thorite, Le Conte was led to regard the mineral as pitch-blende, in which part of the U_2O_3 is replaced by Al_2O_3. This opinion receives some support, by the fact that Scheerer(2) has found upon the mountain-ridge of Strömsheien, near Valle (Norway), pitch-blende crystallized in regular octahedrons with truncated edges. These crystals, frequently of the size of a pea, had the spec. grav. 6·71, and the following composition:

U_3O_4.	(NbO_2, PeO_2, SiO_3, PbO).	MnO.	HO.	Insol. matter and loss.	Total.
76·6	15·6	1·0	4·1	2·7	100·0

According to this analysis, which was performed with not more than 0·718 grms. of substance, the ore was very impure, and, as exhibited by the amount of water, in a very advanced state of decomposition. Nevertheless, if we consider the crystalline form, and the acknowledged analogy of composition of pitch-blende, and of the spinels, the analysis admits of classifying the latter with the spinel-group, and establishes the isomorphism of U_2O_3 with Al_2O_3 &c.

Chrysoberyl.—Haidinger(3) has pointed out that Descloizeaux's measurements of chrysoberyl are only approximately correct, and observes that the latter would have done better had he taken as a model of his investigation, the completeness and accuracy of the

(1) Sill. Am. J. [2] III, 173.
(2) Pogg. Ann. LXXII, 569; N. Jen. Lit-Ztg. 1848, 855.
(3) Haiding. Berichte (comp. II, 379) II, 445.

German crystallographical researches, instead of mentioning in a derogatory manner, the "*quelques nombres de MM. Phillips et Mohs.*"

Hydrated Aluminates. Völcknerite.

Hydrated Aluminates. Völcknerite.—Hermann(1) has analyzed a new and rare mineral, from the talc-slate of the Schischimskaja, near Slatoust, which he obtained from Capt. Völckner.—It occurs in the form of white, nacreous plates, greasy to the touch; and also in hexagonal tables, being very perfectly cleavable in the direction of 0 P, and less so in the direction of ∞ P. Spec. grav. =2·04. It exfoliates before the blow-pipe, and is highly luminous and infusible. Readily soluble in acids with evolution of 3·92 per cent of CO_2, which Hermann considers to have been absorbed from the atmosphere. The composition is 6 (MgO, 2 HO) + Al_2O_3, 3 HO.

	Al_2O_3.	MgO.	HO.	Total.
Found . .	17·65	38·59	43·76	100·00
Calculated .	16·55	39·95	43·50	100·00

From this analysis Rammelsberg has calculated the formula (MgO, Al_2O_3 + 10 HO) + 5 MgO, HO(2), and at a subsequent period the more probable expression: MgO, Al_2O_3 + 5 (MgO, 3 HO)(3).

Silicates in General. Classification.—Chapman(4) has developed a classification of silicates according to purely chemical principles, which essentially agrees with Rammelsberg's(5) synopsis of the formulæ of silicates.

Formulæ and Classification.—Laurent(6) finds the hitherto adopted formulæ of the natural silicates, which are all arranged according to dualistic principles, to be both complicated and fantastical. They are but incorrect expressions of the composition of these minerals, admit of no systematic classification, and obstruct the study of the silicates by numerous incongruities. With the view of remedying all these evils, Laurent proposes new and simpler formulæ which are based upon the assumption that silicic acid, represented by SiO, is polybasic; and farther, that all metallic oxides, capable of forming salts, are composed of equal equivalents of metal and oxygen, being, at least to some extent, isomorphous

(1) J. Pr. Chem. XL, 12.
(2) Rammelsb. Handw. 3. Suppl. 124.
(3) N. Jen. Lit-Ztg. 1848, 855.
(4) Chem. Gaz. 1848, 37.
(5) Rammelsb. Handw. 2. Suppl. 302.
(6) Compt. Rend. XXIII, 1050 and XXIV, 94; J. Pharm. [3] XII, 70 (in abstr.)

Formulæ and classification.

with each other (comp. I. 23). This assumption being admitted, all silicates may be arranged under the following types:

Monosilicates . = $SiO + 2(R)O = SiO_3(R_2)$
Bisilicates . . = $2SiO + 2(R)O = SiO_4(R_2)$
Trisilicates . . = $3SiO + 2(R)O = SiO_5(R_2)$
Tetra-, &c. up to octosilicates.

To every one of these types belongs a number of hydrated or basic sub-types of the form $nSiO + 2(R)O + nRO$.—Rammelsberg(1) has submitted Laurent's theory to a detailed but unfavourable review which appears to have excited the displeasure of Gerhardt(2). It must, however, be acknowledged, that with many silicates the oxygen of the bases RO and R_2O_3 collectively, equals either exactly or very nearly the amount of this element in the silicic acid. Compare, f. i., epidote, idocrase, &c.

A synopsis of the natural silicates, equally acceptable to mineralogists and to chemists, has been elaborated by Rammelsberg(3). It is based upon the ratio of the oxygen contained in their constituents.

Artificial Silicates. (Slags).—John Percy, with the assistance of D. Forbes, has investigated a series of crystallized slags(4).

No.	Spec. Grav.	SiO_3	Al_2O_3	Fe_2O_3	FeO	MnO	CaO	MgO	KO	CaS		Total.
1	2·905	38·05	14·11	—	1·27	0·40	35·70	7·61	1·85	0·82		99·81
2	2·915	38·76	14·48	—	1·18	0·23	35·68	8·84	1·11	0·98		101·26
3	2·924	37·63	12·78	—	3·91	2·64	33·46	6·64	1·92	0·68		99·66
4	2·918	37·91	13·01	—	0·93	2·79	31·43	7·24	2·60	3·65		99·56
5	—	39·52	15·11	—	2·02	2·89	32·52	3·49	1·06	2·15		98·76
6	—	42·06	12·93	—	4·94	2·26	32·53	1·06	2·69	1·03	0·31*	99·81
7	—	28·32	24·24	—	0·27	0·07	40·12	2·79	0·64	3·38	0·26†	100·09
8	—	45·59	11·88	—	1·11	0·91	38·20	—	—	1·76		99·45
9	—	53·37	5·12	—	0·95	1·41	30·71	9·50	—	—		101·06
10	—	53·76	4·76	—	1·48	1·30	29·48	9·82	—	—		100·60
11	—	55·77	13·90	—	2·12	2·52	22·22	2·10	1·78	—	0·46‡	100·87
12	—	22·76	7·30	—	61·28	3·58	3·41	0·76	—	—	—	99·09
13	4·080	29·60	1·28	17·11	48·43	1·13	0·47	0·35	—	—	1·61§	101·32
14	4·188	23·86	0·91	23·75	39·83	6·17	0·28	0·24	—	—	0·62§	102·08

* $2Al_2O_3, 3P_2O_5$. † CaO, SO_3. ‡ S. § FeS.

No. 1. to 6. are slags from iron-furnaces: 1. and 2. from Dudley,

(1) J. Pr. Chem. XL, 374.
(2) J. Pharm. [3] XIII, 70.
(3) Rammelsberg's Handwörterbuch, 3. Suppl. 134; Pogg. Ann. LXXII, 95.
(4) Report of the 16th Meeting of the British Association for the Advancement of Science, 371.

Artificial silicates. (Slags).

3. and 4. from Russelshall, near Dudley, 5. from Wednesbury, near Tipton, and 6. from Marchienne, near Charleroi (Belgium). All these specimens were tetragonal: $\infty P . 0 P$, also with $\infty P \infty$; they were decomposed by hydrochloric acid, and exhibited the composition of humboldtilite: $2 (3 RO, SiO_3) + Al_2 O_3, SiO_3$ (according to Damour's(1) analysis).—No. 7. is likewise an iron-furnace-slag, from Oldbury; white, transparent, tetragonal tables. Percy considers the latter as gehlenite, to which he assigns the formula $3 (3 CaO, SiO_3) + 3 Al_2 O_3, SiO_3$ (comp. gehlenite).—No. 8. is from a cupel-furnace in which cast-iron had been fused with addition of lime; long, yellow, tetragonal prisms, cleavable in the direction of 0 P, and composed like humboldtilite: $3 (2 RO, SiO_3) + Al_2 O_3, SiO_3$ (according to Kobell's(2) analysis).—No. 9 and 10. delicate monoclinometric prisms and radiated masses from the iron-furnaces, near Olsberg, on the Rhine; their composition approaches that of many augites containing alumina.—No. 11. specimen from an iron-furnace near Seraing, and like the preceding one, insoluble in hydrochloric acid.—No. 12. specimen from a refining-furnace at Bromford, near Birmingham.—No. 13 and 14. from a puddle furnace, the latter from Bloomfield, near Tipton; they are rhombic crystals $\infty . \infty \breve{P} \infty . 2 \breve{P} \infty$, with the angles of chrysolite; cleavable in the direction of 0 P. Percy regards them as ferruginous chrysolites, whose iron was subsequently converted into sesquioxide.

Artificial Crystals of Felspar.—In a transparently fused frit, weighing $1\frac{1}{2}$ hundred weight, and to which a considerable quantity of felspar had been added, Prechtl(3) found, after cooling, that a portion of this mineral had again separated in foliated masses, and in several large distinct crystals.

Anhydrous Silicates with Bases $R_2 O_3$. Zircon and Malacon.—Gibbs(4) has analysed light-brown zircon from Litchfield (Maine, North America), spec. grav. = 4·7 (I); and Damour(5) a specimen of malacon (III. and IV.) found by Alluaud, Sen., in the graphic granite of Chanteloube (Haute Vienne). The latter formed small, cinnamon-brown plates of spec. grav. 4·047; a single distinct crystal was found exhibiting a form similar, and angles nearly similar to those of zircon: $P . \infty P \infty . 4 P 4$; $P = 83^0\ 30'$ (middle edge), and $124^0\ 40'$ (polar edge).

(1) Rammelsberg's Handwörterb. 2. Suppl. 64.
(2) Rammelsberg's Handw. I, 315.
(3) Wien. Acad. Ber. II, 230.
(4) Pogg. Ann. LXXI, 559.
(5) Ann. Ch. Phys. [3] XXIV, 87.

Anhydrous silicates with bases $R_2 O_3$. Zircon and malacon.

	SiO_3.	ZrO.	$Fe_2 O_3$.	$Mn_2 O_3$.	CaO.	HO.	Undecomposed residue.	Total.
I.	35·26	63·33	0·79	—	—	—	0·36	99·74
II.	31·23	61·70	2·91	trace.	trace.	3·29	—	99·13
III.	30·87	61·17	3·67	0·14	0·08	3·09	—	99·02

Damour regards the water contained in malacon as an essential constituent, on account of the accordance of his and Scheerer's analyses; while the latter observer himself, together with other authors, explains(1) the difference in the properties of malacon and zircon, by assuming the existence in the former of an allotropic modification of zirconia.

With Bases RO. Agalmatolite.—Schneider(2) has analysed, in Marchand's laboratory, genuine Chinese agalmatolite of the spec. grav. = 2·763.

SiO_3.	MgO.	FeO.	MnO.	$Al_2 O_3$.	HO.	Total.
63·28	31·92	2·26	0·23	0·53	0·78	99·00

This analysis leads to the formula 6 MgO, 5 SiO_3, which Kobell adduces for the talc found at the Greiner and at Prussiansk(3).

Augite.—Delesse(4) has analysed a specimen of asparagus-green augite, from the porphyry of Ternuay (I); spec. grav. = 3·135.—Gruner(5) has investigated a pale greenish-grey mineral of satiny lustre, from Collobrières (Depart. du Var.), where it occurs with magnetic iron and garnet, forming a considerable bed in the mica-slate. Spec. grav. = 3·713 (II).

	SiO_3.	$Al_2 O_3$.	FeO.	MnO.	CaO.	MgO.	HO.	Total.
I.	49·00	5·08	7·19	trace	18·78	15·95	2·26	98·26
II.	43·90	1·90	52·20	—	0·50	1·10	—	99·60

Delesse considers the water of augite as polymero-isomorphous; but irrespectively of this assumption his analysis leads to the formula of augite, if the joint amount of oxygen in SiO_3 and $Al_2 O_3$ are introduced into the calculation.—Gruner considers the mineral which he investigated as ferruginous augite. The formula 3 FeO, 2 SiO_3 requires 54·38 per cent of FeO, and 45·62 of SiO_3, values which closely agree with the results of his analyses.

Hornblende.—Delesse(6) has analysed (I) a specimen of green, foliaceous, and fibrous hornblende from the spherical diorite of

(1) Pogg. Ann. LXII, 436; Berz. Jahresber. XXV, 327; Rammelsberg's Handwörterb. 2. Suppl. 179.

(2) J. Pr. Chem. XLIII, 317.

(3) Kastner's Arch. XII, 29; Rammelsb. Handw. II, 189.

(4) Compt. Rend. XXV, 637; J. Pr. Chem. XLV, 223; Jahrb. Miner. 1848, 34.

(5) Compt. Rend. XXIV, 794; Ann. des Mines [4] XIV, 300.

(6) Ann. Ch. Phys. [3] XXIV, 437: Compt. Rend. XXVII, 411; Institut. 1848, 325.

Corsica; spec. grav. = 3·08; and likewise of a dark-green, crystallized variety (II) of difficult fusibility, from the syenite of Servance(1); spec. grav. = 3·114. A sample of hornblende from Kimito (III) has been examined by Moberg(2). Hornblende.

	SiO_3.	Al_2O_3.	Cr_2O_3.	FeO.	MnO	CaO.	MgO.	NaO.	KO.	HO and HFl.	Total.
I.	47·88	8·23	0·50	16·15	tracc	7·05	18·40	0·65	0·14	1·00	100·00
II.	47·40	7·35	—	15.40	trace	10·83	15·27	2·95		(HO) 1·00	100·20
III.	43·23	11·72	—	26·81	1·60	9·71	7·03	—	—	—	100·10

Assuming that 1 equiv. of Al_2O_3 can be substituted without change of form for 1 equiv. of SiO_3, the two first analyses give the proportion of oxygen of RO to that of $SiO_3 + Al_2O_3$ nearly as 4 : 9. The latter exhibits the ratio 4 : 9·556.

Chrysolite.—Genth(3) has analysed small, bright, yellowish-green grains of chrysolite (I) of a highly vitreous lustre, from the Thjorsa lava of Hecla (comp. the article on lavas); spec. grav. = 3·226 at 17°.—Rhodius(4) has examined a specimen of decomposed opaque olivine (II) of waxy lustre, obtained from the disintegrated basalt of the Virneberg, near Rheinbreitbach. Spec. grav. = 1·98. Entirely decomposed by hydrochloric acid (comp. II, 383).

	SiO_3.	MgO.	Fe_2O_3	FeO.	NiO.	CoO.	Al_2O_3	Total.
I.	43·44	49·31	—	6·93	0·32	trace	trace	100·0
II. a)	49·2	16·8	1·4	31·5	—			98·9
II. b)	53·6	18·0	0·7	26·1	—	—	—	98·4
Calc. accord. to Rh.	52·7	17·5	—	29·8	—	—	—	100·0

Genth's analysis leads to the recognised formula 3 RO, SiO_3. Rhodius has calculated $2\,SiO_2\,(MgO, FeO) = 2\,SiO_3, 3\,(MgO, FeO)$, according to which this specimen of olivine had lost $\frac{1}{2}$ of its bases by decomposition.

Willemite.—In the laboratory of Rammelsberg a specimen of willemite from Upper-Silesia (I) has been analysed by Rosengarten(5); Monheim(6) has examined a similar mineral from the Busbacher Berg, near Stolberg; the one a crystalline specimen of spec. grav. 4·18 (IIa); the other a compact specimen of spec. grav.

(1) Ann. des Mines [4] XIII, 679; Mémoires de la Société d'Emulation du Doubs, 1847; J. Pharm. [3] XII, 456 (in abstr.); Arch. Ph. Nat. V, 341.
(2) Act. Soc. Sc. Fenn. II, 810; J. Pr. Chem. XLII, 454.
(3) Ann. Ch. Pharm. LXVI, 19.
(4) Ann. Ch. Pharm. LXIII, 216.
(5) Rammelsb. Handw. 3. Suppl. 65.
(6) Verhandlungen des Naturh. Vereins der Preuss. Rheinl. 1848, 162.

Willemite. of from 4·02 to 4·16 (IIb). It was the latter mineralogist who first observed the occurrence of willemite at the Busbacher Berg, as well as at the Altenberg, near Aachen. All the analyses agree with the formula 3 ZnO, SiO_3.

	SiO_3.	ZnO.	Fe_2O_3.	FeO.	CaO.	MgO.	CO_2.	Total.
I.	27·34	70·82	—	1·81	—	—	—	99·97
II. a.	26·90	72·91	0·35	—	—	—	—	100·16
II. b.	26·53	69·06	4·36	—	0·41	0·13	0·04	100·53
Calculation	27·11	72·89	—	—	—	—	—	100·00

Bagrationite.—Kokscharow(1) has described and named a mineral found by the Prince Bagration in the Achmatowsk mine, on the Ural Mountains. Monoclinometric; principal axis: clinodiagonal: orthodiagonal = 1 : 1·7504 : 1·1288, $a = 65^0\ 5'$. Measured angles : 0 P : ∞ P = $104^0\ 8'$; ∞ P : ∞ P ∞ = $125^0\ 25'$; P : ∞ P = $150^0\ 41'{\cdot}5$. Calculated : ∞ P = $70^0\ 50'$ in the clinodiagonal principal section; 0 P : — P ∞ = $157^0\ 20$; — P : — P = $118^0\ 16'{\cdot}9$; 2 P : 2 P = $71^0\ 35'{\cdot}6$. ∞ P . ∞ P ∞.—P ∞ . 0 P . $\frac{2}{3}$ P . P ∞ . 2 P ∞ . 4 P ∞.—P . 2 P.—4 P 2 were observed.—This mineral exhibits no cleavage; fracture conchoidal and uneven; hardness = 6·5; spec. grav. = 4·115. Colour black and opaque, streak brown; lustre vitreous, on 0 P imperfectly metallic. Insoluble in acids; before the blow-pipe it forms a cauliflower-like intumescence, and fuses to a black magnetic bead. With fluxes it exhibits the reactions of iron.—In consequence of the agreement in hardness, spec. grav., and crystalline form, Kokscharow considers it to be closely allied to gadolinite. As yet no analysis has been made of it.

Anhydrous Silicates with Bases RO and R_2O_3. Epidote.—Marignac(2) has measured and figured a remarkably brilliant crystal of epidote, with numerous faces, from Vesuvius, as well as some others from the Lenzthal and the Dauphinée. Marignac placed the crystal in such a manner as to take for its base the plane which Naumann denotes by ∞ P ∞; we here express the angles by representing the planes according to the position adopted by Naumann; — P = $69^0\ 56'$; P = $70^0\ 14'$; ∞ P = $62^0\ 48'$ (the three in the clinodiagonal principal section); ∞ P ∞ : — P ∞ = $115^0\ 27'$; from which $a = 89^0\ 35'$. Probably the angles of — P and P are mistaken for each other, for a would fall below the long terminal

(1) Pogg. Ann. LXXIII, 182.
(2) Arch. Ph. Nat. IV, 148.

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11. a.	11. b.	12.
	Zoisite from Passeyer.	Brown epidote from the Rothlaue.	Grey zoisite from Falltigl.	Green zoisite from Arendal.	Green zoisite from the Nasimskaja, near Achmatowsk.	Green zoisite from the Schumnaja.	Blackish-green pistazite from Arendal.	Blackish-green pistazite from Burowa.	Dichromatic pistazite from Werchneiwinsk (Puschkinite).	Pistazite from Bourg. d'Oisans.	Grass-green transparent pistazite from Achmatowsk.		Bucklandite from Achmatowsk.
Spec. grav.		3·387	3·28	3·37	3·34	3·43	3·49	3·35	3·43	3·38	3·39		3·51
SiO_3	40·57	44·56	40·95	37·32	36·45	37·47	36·79	36·87	37·47	37·60	36·87	37·38	36·97
Al_2O_3	32·67	23·72	30·34	22·85	24·92	24·09	21·24	18·13	18·64	18·57	18·72	18·25	21·84
Fe_2O_3	—	8·33	—	11·56	9·54	10·60	12·96	14·20	14·15	13·37	12·34	12·31	10·19
FeO	4·60	—	4·96	1·86	3·25	2·81	5·20	4·60	2·56	5·55	2·20	2·20	9·19
CaO	20·81	24·71	21·56	22·03	22·45	22·19	21·27	21·45	22·06	21·19	24·79	24·72	21·14
MgO	—	—	—	0·77	—	—	—	0·40	—	1·40	0·39	0·39	—
NaO	—	—	—	—	—	—	—	0·08	2·28*	—	0·91	0·91	—
HO	1·22	—	0·56	0·29	0·77	0·34	0·55	0·67	0·65	0·46	0·59	0·59	0·68
CO_2	—	—	1·13	2·64	2·73	1·90	2·31	0·87	0·79	1·22	1·61	1·61	0·32
BO_3	—	—	—	—	—	—	—	traces	—	—	traces	traces	—
	99·87	101·32	99·50	99·32	100·11	99·40	100·32	97·29	98·60	99·36	98·42	98·36	100·33

* Together with some lithia.

[TO FACE II. PAGE 403.]

edge of the octahedron. In other respects the measurements closely agree with those of Haidinger and Kupffer.

Richter(1) has investigated zoisite (the so-called spodumene) from Passeyer, Rammelsberg(2) crystallized dark-brown epidote from the Rothlaue, near Guttannen, and Hermann(3) nine varieties of epidote, besides a specimen of bucklandite from Achmatowsk, which had hitherto been regarded as black sphene. According to Auerbach the latter has the crystalline form of ordinary epidote; as G. Rose had previously established for the bucklandite from Werchoturje, from the Lake of Laach; with the difference only, that the crystals are elongated in the direction of the edges of — P, instead of the orthodiagonal. The crystals are combinations of P . — P . ∞ P . — P ∞ and (P ∞).—The epidotes, as is the case with the tourmalines, contain, according to Hermann, nearly 2 per cent of carbonic acid, which according to his view, replaces a portion of the silicic acid (SiO_2) without change of form.

The analyses are comprised in the accompanying table.

Analyses No. 1 and 2 lead to the generally adopted formula 3 RO, SiO_3 + 2 (R_2O_3, SiO_3). As this formula, however, is not in accordance with Hermann's analyses, except with No. 3 and 4, he arranges bucklandite, orthite, allanite, and cerine (comp. II, 404) together, and assumes for the epidote three heteromeric types (comp. II, 380):

	Ratio of oxygen of RO : R_2O_3 : $SiO_2 + CO_2$.	Formula.
A. Zoisites	1 : 2 : 3	3 (2 RO, [SiO_2, CO_2]) + 2 (2 R_2O_3, 3 SiO_2)
B. Bucklandites	1 : 1·5 : 2·5	2 „ „ „ + 1 „ „
C. Orthites	1 : 1 : 2	3 „ „ „ + 1 „ „

To A belong, in addition to the epidotes, No. 3, 4, 5, and 6, those from Falltigl (Geffken), and from the Fichtelgebirg (Bucholz), Thulit (Gmelin), with amite from Glencoe (Brewster), &c. No. 10, 11 and 12 belong to B. The pistazites under 7, 8 and 9, he considers as heteromeric compounds of zoisite and bucklandite. No. 7 = 2 A + B, No. 8 and 9 = 2 A + 3 B. The orthites are divided into farther heteromeric members, according to the amount of water they contain.—Hermann states that almost all epidotes contain at the same time FeO and Fe_2O_3. Direct experi-

(1) Haidinger's Berichte (comp. II, 379) III, 114.
(2) Rammelsberg's Handw. 3. Suppl. 43.
(3) J. Pr. Chem. XLIII, 35. 81.

Epidote.

ments, however, made by Rammelsberg(1), in reference to this question, have proved that epidote from Arendal, at least, contains no FeO, and agrees with the usual formula. He believes that, in Hermann's experiments, a portion of the Fe_2O_3 was reduced by too powerful ignition.

Hermann(2) has analysed bucklandite (I.) from Werchoturje, and also ural-orthite (II.) from Miask (spec. grav. 3·55), which had at an earlier period been investigated by him(3), as well as by Choubine(4), under the name of tschewkinite.

	SiO_3.	Al_2O_3.	Fe_2O_3, FeO.	CeO.	LaO.	YO.	CaO.	MgO.	HO.	Total.
I.	32·46	18·09	13·84	6·77	9·76	1·50	13·18	1·02	3·40	100·0
II.	34·47	14·36	7·66 8·23	14·79	7·66	—	10·20	1·07	1·56	100·0

For ural-orthite Hermann calculates the ratio of oxygen of $HO : RO : R_2O_3 : SiO_3 = 1 : 6 : 6 : 12$, leading to the formula $2\,(3\,RO, SiO_3 + R_2O_3, SiO_3) + HO$, which agrees with Berlin's analysis of orthite from the Zoological Gardens at Stockholm(5). The same result has been obtained by Rammelsberg in the analysis of orthite from Hitteroën(6), with the exception of the double amount of water contained in the latter.

As the bucklandite from Werchoturje, which according to G. Rose has the crystalline form of epidote, exhibits the composition of the orthites, Hermann and Auerbach have compared the crystalline form of orthite, allanite, and cerine, with that of epidote, and arrived at the interesting result, confirmed at a subsequent period by Koksharow(7), that all these minerals are of the same form. Hermann, therefore, arranges orthite, allanite, and cerine, as members, heteromeric with epidote (comp. II, 403), and adduces, moreover, the fact, that Nordenskjöld has recently found the pistazite from Sillböhle (Finland) to occur in most cases with a nucleus of orthite.—Ural-orthite has only recently been met with in the crystalline state. Crystalline form = $P\infty\,.\,\infty P\infty\,.\,-P\infty\,.\,P\,.\,(P\,3)$. General form tabular, in consequence of the preponderance of $P\infty$. The crystal measured by Koksharow possessed the general form of epidote.

Bodenite and Muromontite.—Kerndt(8) has analysed a mineral (I.) which he had discovered in the oligoclase, between Boden and

1) N. Jen. Lit-Ztg. 1848, Nr. 230 u. 305.
(2) J. Pr. Chem. XLIII, 35. 81; Jahrb. Miner. 1848, 816 (in abstr).
(3) J. Pr. Chem. XXIII, 273.
(4) Berzelius' Jahresber. XXVI, 373.
(5) Berzelius' Jahresber. XXVI, 369.
(6) N. Jen. Lit.-Ztg. 1848, 1218.
(7) J. Pr. Chem. XLIV, 204.
(8) J. Pr. Chem. XLIII, 182.

Bodenite and muromontite.

Mauersberg, near Marienberg, in Saxony, and for which Breithaupt(1) had proposed the name bodenite. Hitherto it has been found only in indistinct rhombic (?) prisms of 110° to 112° with no indications of cleavage. Hardness = 6·5, spec. grav. = 3·523. Colour reddish, or blackish-brown; streak dirty white; lustre vitreous, opaque. Like gadolinite, it becomes incandescent on ignition; infusible, except on the sharp edges; decomposable by strong acids. —With the bodenite are found black amorphous grains of spec. grav. 4·263, which do not exhibit the phenomenon of incandescence on ignition. Kerndt has also analysed the latter (II): he considers them, with Kersten(2), as a species distinct from bodenite, to which he assigns the name of muromontite; he adds, however, that it possibly may be a mixture.

	SiO_3.	Al_2O_3.	FeO.	YO.	BeO.	CeO.	LaO.	MnO.	CaO.	MgO.	KO.	NaO.	HO.	Total.
I.	26·12	10·33	12·04	17·43	—	10 46	7·56	1·61	6·32	2·33	1·21	0·84	3·01	99·26
II.	31·08	2·23	11·23	37·14	5·51	5·54	3·53	0·90	0·70	0·42	0·17	0·65	0·84	99·94

Kerndt calculates for bodenite the formula 9 RO, 2 $Si\,O_3$ + $Al_2\,O_3$, $Si\,O_3$, in which the water, estimated at 1 equiv., is assumed to be basic. The formula 5 (3 RO, $Si\,O_3$) + 2 $Al_2\,O_3$, $Si\,O_3$ + 3 HO, reminds us of that of orthite, and appears more probable, provided the water be essential.

Idocrase.—Hermann(3) has analysed the hitherto uninvestigated idocrases from the Ural, with special reference to the state of oxidation in which the iron exists.—I. Wiluite, from the River Wilui, in crystals 2 inches in length, : 0 P . ∞ P . P . ∞ P ∞; tabular from the preponderance of 0 P; colour brownish-green; in thin splinters transparent, spec. grav. = 3·375, readily and quietly fusible; after fusion decomposable by hydrochloric acid.—II. Idocrase, from the Nasimskaja. Of the same form as the foregoing; colour pistachio-green; translucent; spec. grav. = 3·40; experiences, on ignition, a loss of 0·70 per cent of CO_2.—III. Idocrase, from Paläkowsk, in the district of Slatoust. In veins running through serpentine; compact, fibrous; more rarely in crystals, distinguished by the prevalence of 3 P 3, and the absence of 0 P. Colour bright asparagus-green; transparent; spec. grav. = 3·42.—IV. So-called chrysoprase, from Kyschtim, occurring as rolled pebbles in the gold-washings. Compact, apple-green, translucent, spec. grav. = 3·3 to 3·37. A similar idocrase (the so-called prehnite, from Katharinenburg) is found near Mramorsk.

(1) Pogg. Ann. LXII, 273.
(2) Pogg. Ann. LXIII, 135.
(3) J. Pr. Chem. XLIV, 194.

Idocrase.

	SiO_3.	Al_2O_3.	Fe_2O_3.	FeO.	MnO.	CaO.	MgO.	KO and NaO.	CO_2.	Total.
I.	38·23	14·32	5·34	1·03	0·50	34·20	6·37	—	—	99·99
II.	37·62	13·25	7·12	0·60	0·50	36·43	3·79	—	0·70	100·01
III.	38·18	14·34	5·26	0·61	2·10	32·68	6·20	—	—	99·37
IV.	39·20	16·56	1·20	0·30	—	34·73	4·00	2·00	1·50	99·49

In the place of the hitherto adopted formula of garnet, Hermann proposes, as resulting from these analyses, the expression 3 (3 RO, SiO_2) + 2 (Al_2O_3, 2 SiO_2) for idocrase, which assumes the ratio of oxygen of RO : R_2O_3 : SiO_2 = 9 : 6 : 14. If silicic acid be expressed by SiO_3 this ratio approximates to 9 : 6 : 15, and gives the formula 3 (3 RO, SiO_3) + 2 Al_2O_3, SiO_3), according to which, idocrase would contain $\frac{1}{3}$ less silicate of alumina than garnet; hence the difference in the form of the two minerals becomes intelligible. That Hermann's assumption is not unfounded is shown by the following synopsis(1) of the ratio of oxygen derived from several analyses of idocrase previously published.

	Hermann.				From the Schischimskaja.			From Monzoni,	From the Sasserthal.	From Cziklowa.	From Egg.	From Piedmont.
					Magnus.	Varrentrapp.		Kobell.	Karsten.	Magnus.	Magnus.	Karsten.
	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.
RO	9	9	9	9	9	9	9	9	9	9	9	9
R_2O_3	5·90	6·16	6·14	6·07	6·39	5·96	6·00	5·24	7·14	7·52	5·97	6·41
SiO_3	14·42	14·77	15·03	15·58	14·90	14·21	14·32	14·53	15·06	16·39	14·41	15·77

Pyrope.—Moberg(2) has investigated Bohemian pyrope with special reference to the state of oxidation in which the iron and chromium exist. As the finest powder suffers no diminution of weight by ignition in hydrogen, but, on the contrary, increases 0·37 per cent when heated in atmospheric air, as moreover, the colour of the mineral does not point to Cr_2O_3, he assumes the iron and chromium in the pyrope to exist in the form of protoxides, and accordingly calculates the results of his analysis as follows :

SiO_3.	Al_2O_3.	FeO.	CrO.	MnO.	CaO.	MgO.	Total.
41·35	22·35	9·94	4·17	2·58	5·29	15·00	100·68

The ratio of oxygen contained in RO : R_2O_3 : SiO_3 accordingly is = 11·15 : 10·44 : 21·48 = 1 : 1 : 2, as is the case with garnet, with which pyrope had been previously associated by Trolle-Wachtmeister.

(1) V. to XII. according to Rammelsb. Handw. 2. Thl. 256.
(2) J. Pr. Chem. XLIII, 114.

Thjor sauite

Thjorsauite.—Genth(1) has described a new mineral which is found together with chrysolite imbedded in thjorsa-lava (comp. the article on lavas). Monoclinometric? Distinctly cleavable in one direction. Fracture uneven, partly conchoidal; brittle. Lustre vitreous; upon the planes of cleavage, nacreous. Transparent; colour white, inclining to grey; streak white; hardness = 6; spec. grav. = 2·688. In thin splinters fusible before the blow-pipe. Not decomposable by hydrochloric acid.

	SiO_3.	Al_2O_3.	Fe_2O_3.	MgO.	CaO.	NaO.	KO.	Total.
I.	49·15	—	1·62	trace	17·28	—	—	—
II.	48·36	30·59	1·37	0·97	17·16	1·13	0·62	100·20

Genth proposes the formula $2\ (3\ RO, 2\ SiO_3) + 5\ Al_2\ O_3, SiO_3)$, and calls attention to the intimate relation of this mineral to scapolite, barsowite and bytownite, in which the silicates of RO and $R_2O_3 = 1 : 2$ and $1 : 3$, while in the case of thjorsauite the relation $= 1 : 2\frac{1}{2}$.

Gehlenite.—Rammelsberg(2) has investigated crystallized gehlenite from the Monzoni Hill, with special reference to the degree of oxidation of the iron, which he determined according to the method of Fuchs.

SiO_3.	Al_2O_3.	Fe_2O_3.	FeO.	MnO.	CaO.	MgO.	Loss and HO.	Total.
29·78	22·02	3·22	1·73	0·19	37·90	3·88	1·28	100·0

Instead of the earlier and generally adopted ratio of oxygen of $RO : R_2O_3 : SiO_3 = 2 : 2 : 3$, the analysis yielded $3 : 3 : 4$, according to which Rammelsberg considers the true formula of gehlenite to be $3\ (3\ RO, SiO_3) + 3\ R_2O_3, SiO_3$.

Jacksonite.—The name jacksonite has been given by Whitney(3) to a new mineral from Kewenaw-Point and Isle-Royal on Lake Superior, North America, which is very similar to prehnite. Radiated fibrous, or radiated lamellar masses. Translucent, greenish-white. Hardness = 6; spec. grav. = 2·881: Fusible before the blow-pipe with powerful intumescence. Completely decomposable by hydrochloric acid, with separation of silicic acid in the form of powder. The formula is that of prehnite (Walmstedt) exclusive of the water; $2\ CaO, SiO_3 + Al_2O_3, SiO_3$.

	SiO_3.	Al_2O_3.	CaO.	NaO.	Total.
Calculation . .	46·18	25·69	28·13	—	100·00
Experiment . .	46·12	25·91	27·03	0·85	99·91

(1) Ann. Ch. Pharm. LXVI, 18.
(2) Rammelsb. Handw. 3. Suppl. 47.
(3) Journ. Boston Soc. Nat. Hist. V, 486; Sill. Am. J. [2] VI, 269 (in abstr.)

Fel-spars. Baulite.

Felspars. Baulite.—The distinct character of baulite, considered as a new species by Forchhammer(1), but regarded by Rammelsberg(2) as a fused mixture of felspar and quartz, has been decided beyond all doubt by Genth's(3) investigation of an eruptive product of the Krabla, which Bunsen had collected. Genth, as well as Forchhammer, found the ratio of oxygen contained in RO : R_2O_3 : SiO_3 constantly = 1 : 3 : 24; the latter, moreover, observed the mineral in the crystalline state. The compact mineral occurs in vitreous colourless translucent, or even transparent, granular crystalline aggregates, of an uneven, somewhat conchoidal fracture, but exhibiting no decided cleavage. The small crystals which do not admit of measurement belong to the monoclinometric system, and exhibit combinations of $\infty P . \pm P \infty$ or $0P . \pm mP$. Hardness = 5·5 to 6; spec. grav. = 2·656. In thin splinters, fusible before the blow-pipe into a colourless glass: not attacked by hydrochloric acid. Analysis gave:

SiO_3.	Al_2O_3.	CaO.	NaO.	KaO.	MgO and MnO.	Total.
80·23	11·71	1·46	2·26	4·92	traces	100·58

numbers leading to the formula given by Berzelius, RO, 2 SiO_3 + Al_2O_3, 6 SiO_3.

Orthoclase.—Delesse has investigated: I. Pale-yellow felspar from the syenite of the Ballon de Servance(4). Compact, also in twin crystals similar to those of Karlsbad. Hardness somewhat below 6; spec. grav. = 2·551. Before the blow-pipe fusible with difficulty to a vesicular glass.—II. White felspar(5). Porphyry imbedded in the so-called arkose of the Vosges. Spec. grav. ?

	SiO_3.	Al_2O_3.	Fe_2O_3.	CaO.	MgO.	KaO.	NaO.	HO.	Total.
I.	64·26	19·27	0·50	0·70	0·77	10·58	2·88	0·40	99·36
II.	61·57	18·98	trace	0·58	0·30	12·69	1·59	—	98·71

No. I. gives the ratio of oxygen contained in RO : R_2O_3 : SiO_3 = 1 : 3·01 : 11·02; No. II. = 1 : 3·11 : 11·25.

Pericline.—At the suggestion of Haidinger, Hubert(6) has investigated the well-known, beautifully crystallized pericline, from

(1) Berzelius' Jahresber. XXIII, 261.
(2) Rammelsb. Handw. 2. Suppl. 23.
(3) Ann. Ch. Pharm. LXVI, 270.
(4) Compt. Rend. XXV, 103 (it is here stated that NaO = 6·44; KO = 6·40); Ann. des Min. [4] XIII, 671 (NaO and KO as given above); J. Pharm. [3] XII, 455 (in abstr.); Arch. Ph. Nat. V, 332; Jahrb. Miner. 1848, 769.
(5) Arch. Ph. Nat. VII, 177.
(6) Wien. Acad. Ber. 2. Hft. 193.

the Pfitschthal: I. A transparent crystal; II. a specimen which had acquired the appearance of porcelain owing to the commencement of disintegration. Pericline

	SiO_3.	Al_2O_3.	CaO.	NaO.	Total.
I.	69·00	19·50	1·10	9·05	98·65
II.	70·66	18·33	0·53	10·00	99·52

Ratio of the oxygen contained in I. RO : R_2O_3 : SiO_3 = 1 : 3·46 : 13·64
" " " " II. " " " = 1 : 3·16 : 13·55

Haidinger states, that pericline has been frequently found covered with small, regularly arranged crystals of adularia; the reverse being the case in the felspar from the Cavalierberg, near Hirschberg, in Silesia. In the interior of the latter, moreover, are to be found small crystals of albite. According to Haidinger, they are formed at the expense of the mother-crystal.

Oligoclase.—Kerndt(1) has investigated the leek-green oligoclase, from Boden, near Marienberg (I), in which the bodenite and muromontite are imbedded (comp. II, 404). Lustre remarkably resinous; upon the plane of cleavage, nacreous and vitreous. In thin splinters translucent. Hardness somewhat above 6; spec. grav. (in small fragments) = 2·66, in powder = 2·68.

Kerndt(2) has, moreover, investigated the compact, but rarely crystalline, leek-green felspar from Bodenmais (II), occurring together with magnetic pyrites, quartz, &c. The crystals are distinguished by the predominance of P∞ (the form of pericline?) Cleavage very distinct in two directions (angles unknown). Semi-transparent in thin splinters. Hardness = 6. Spec. grav. of small fragments = 2·546, of the powder = 2·549 at 15°. Before the blow-pipe fusible to a vesicular glass, but less easily than the preceding mineral. According to the mean of two determinations, of which one was effected by means of hydrofluoric acid, the other with carbonate of soda, its composition is:

	SiO_3.	Al_2O_3.	Fe_2O_3.	Mn_2O_3.	FeO.	MnO.	CaO.	MgO.	KO.	NaO.	Total.
I.	61·96	22·66	0·35	0·40	—	—	2·02	0·10	3·08	9·43	100·0
II.	63·66	17·27	—	—	0·45	0·15	0·39	2·28	10·66	5·14	100·0

No. I. gives the ratio of oxygen contained in RO : R_2O_3 : SiO_3 = 1 : 3 : 9, as required by the formula of oligoclase; in No. II. it is = 1 : 1·91 : 7·83, and therefore differs from that of all the known felspars. Kerndt considers it = 3 : 6 : 24, and calculates the formula 3 RO, 2 SiO_3 + 2 (Al_2O_3, 3 SiO_3).

(1) J. Pr. Chem. XLIII, 215. (2) J. Pr. Chem. XLIII, 207.

Andesine.

Andesine.—Together with orthoclase from Servance, as well as in the syenite of several other ballons of the Vosges, Delesse has met with a felspar which, on investigation, was found to agree with Abich's andesine. Cleavable in three directions, the planes of most perfect cleavage forming an angle of $86^0\ 11'$, and like albite, exhibiting delicate twin striæ. In the fresh state, translucent, and greyish-, or greenish-white; becoming, by disintegration, opaque, milk-white, or coral-red, and finally yielding a dirty-white kaolin. More readily fusible than orthoclase; of the same degree of hardness. The following specimens were analysed: I. a milk-white variety from Servance, spec. grav. = 2·683(1); II. a coral-red kind from Coravillers, spec. grav. = 2·651(2); III. a greenish specimen from Chagey (Haute-Saône), spec. grav. = 2·736(3).

	SiO_3.	Al_2O_3.	Fe_2O_3.	MnO.	CaO.	MgO.	NaO.	KO.	HO.	Total.
I.	58·92	25·05	trace	trace	4·64	0·41	7·20	2·06	1·27	99·55
II.	58·91	24·59	0·99	trace	4·01	0·39	7·59	2·54	0·98	100·00
III.	59·95	24·13	1·05	trace	5·65	0·74	5·39	0·81	2·28	100·00

In his calculation, Delesse assumes the water to be basic; irrespectively of this assumption, however, his analyses closely agree with the formula of andesine 3 RO, 2 SiO_3 + 3 (R_2 O_3, 2 SiO_3).

Labradorite.—Delesse(4) has investigated the following varieties of labradorite: I. a green crystallized specimen from the melaphyre of Belfahy (Haute-Saône). Spec. grav.=2·719. Difficultly fusible, and slowly decomposed by sulphuric and hydrochloric acids.—II. a greenish-white kind from the porphyry of the old quarries of Laconia. Spec. grav. = 2·883.—III. a variety from Tyfholen-Udden, in Norway. Spec. grav.?—Moreover: IV. greenish specimens(5) from Ternauy a, and from Haut Rovillers b, (basis of the porphyry of that place). Crystals with two directions of cleavage and delicate twin striæ; lustre resinous; spec. grav.=2·771. Fusible before the blow-pipe to a white vesicular glass; more readily attacked by hydrochloric acid than the ordinary labradorite.—V. a greenish-white, nacreous specimen, from the spherical diorite of Corsica(6). Thin laminæ with twin striæ. Spec. grav.=2·737. Readily and perfectly decomposed by hydrochloric acid with separation of silicic acid in the form of powder.

(1) and (2) Loc. Cit. II, 408 (comp. at orthoclase from Servance).

(3) Compt. Rend. XXV, 636; Jahrb. Miner. 1848, 41.

(4) Mém. de la Soc. d'Emulation du Doubs, 1847; Arch. Ph. Nat. V, 258; J. Pharm. [3] XII, 298. J. Pr. Chem. XLIII, 417.

(5) Ann. d. Chim. [4] XII, 287; Compt. Rend. XXV, 636 (in abstr.); J. Pr. Chem. XLV, 219; Jahrb. Miner. 1848, 34.

(6) Compt. Rend. XXVII, 411; Ann. Ch. Phys. [3] XXIV, 435.

Labradorite.

	SiO_3.	Al_2O_3.	Fe_2O_3.	FeO.	MnO.	CaO.	MgO.	KO.	NaO.	HO.	Total.
I.	52·89	27·39	1·24	—	0·30	5·89	trace	4·58	5·29	2·28	99·86
II.	53·20	27·31	1·03	—	trace	8·02	1·01	3·40	3·52	2·51	100·00
III.	55·70	25·23	1·71	—	—	4·94	0·72	3·53	7·04	0·77	99·64
IV. a.	48·83	32·00	1·50	—	—	4·61	—	—	—	—	—
b.	49·32	30·07	0·70	—	0·60	4·25	1·96	4·45	4·85	3·15	99·35
V.	48·62	34·66	—	0·66	—	12·02	0·33	1·06	2·55	0·49	100·39

Delesse, in accordance with Scheerer's views, considers the water in all these varieties as primary and basic. However, as No. IV. and V. do not exactly yield the ratio of oxygen contained in RO : R_2O_3 : SiO_3 = 1 : 3 : 6, as required by the formula of labradorite, Delesse assumes the ratio = 1 : 3 : 5, and regards the mineral as a new species, vosgite = 3 ([RO], SiO_3) + 3 R_2O_3, SiO_3. Rammelsberg(1), on the contrary, justly asserts it to be partially decomposed labradorite. If the calculation be based upon the alumina which remains after decomposition, and the water be left out of consideration, we arrive, for No. 4, at the ratio of oxygen = 0·86 : 3 : 5·4, from which it appears that the view of Rammelsberg is not unfounded.

Mica.—Marignac(2) has described blackish-green monoclinometric mica from the Binnenthal (Valais). It exhibited a combination of ∞ P . (∞ P m) . (∞ P ∞) . m P and 0 P, the latter plane, of a silvery lustre, being perpendicular to the acute edges of ∞ P. By repeated measurement with the reflective-goniometer, Marignac found ∞ P : ∞ P = 120° 40′ in the clinodiagonal principal section; 0 P : ∞ P = 94° 50′, from which *a* is calculated = 84° 27′; ∞ P : (∞ P ∞) = 119° 40′. From approximative measurement, ∞ P : (∞ P m) = 150°, from which we derive for (∞ P m) 60° 40′ in the clinodiagonal principal section; 0 P : (∞ P m) = 92° and 0 P : m P = 81° 30′. In a large crystal of mica from Monroe (New York), Kengott(3) found, by means of the common goniometer, ∞ P only = 112° and 0 P : ∞ P = 109° 15′.

Marignac(4) has also measured yellow crystals of hexagonal mica from Vesuvius. They exhibited combinations of 0 P and ∞ P, with three pyramids of an inclination 95° 37′, 98° 23′ and 102° 28′ towards 0 P. The alternate polar edges of the pyramids were replaced by the planes of a rhombohedron, for which R : R was found = 62° 46′ (over the polar edge) and R : 0 P = 99° 40′.

Hydrated Silicates with Bases R_2O_3.—Amorphous Silicates of Alumina.—The following hydrated silicates with bases R_2O_3 have been investigated: I. a white, striated lithomarge, from Schlacken-

(1) J. Pr. Chem. XLIII, 417 and XLV, 219.
(2) Arch. Ph. Nat. VI, 301.
(3) Pogg. Ann. LXXIII, 601.
(4) Arch. Ph. Nat. VI, 300.

Hydrated silicates with bases R_2O_3.

walde, by Rammelsberg(1). Highly luminous before the blowpipe, infusible, and not decomposed by hydrochloric acid.—II. White halloysite from the Altenberg, near Aix-la-Chapelle, by Monheim(2). Occurs as a coating on zinc-glass and zinc-spar. Spec. grav. = 2·21. —III. Halloysite, from Montmorillon, by Damour and Salvetat(3), in nests imbedded in clay. Saponaceous to the touch, crumbles in water, without, however, becoming plastic. Infusible. It yields to a hot solution of soda 3·2 per cent of SiO_3, and to hydrochloric acid, without effervescence, CaO, MgO, KO, MnO, Fe_2O_3, together with some Al_2O_3. By alternate treatment with both of these reagents it is completely decomposed. At 100° it pertinaciously retains 15·12 per cent of water.—IV. Highly translucent coating on gray-wacke, from the Silbernaaler Zug, near Clausthal, by Kaiser(4). Hitherto considered as lithomarge. Spec. grav. = 2·552. Infusible.

Amorphous silicates of alumina.

	SiO_3.	Al_2O_3.	Fe_2O_3.	CaO.	MgO.	ZnO.	KO.	NaO.	HO.	Total.
I.	43·46	41·48	—	1·20	—	—	—	0·37	13·49	100·00
II.	40·31	33·23	—	—	—	1·23	—	—	23·69	98·46
III. a.	50·04	20·16	0·68	1·46	0·23	—	1·27	trace	26·00	99·84
III. b.	49·40	19·70	0·80	1·50	0·27	—	1·50	trace	25·67	98·84
IV.	57·70	27·10	—	0·80	1·41	—	—	—	14·00	101·01

No. I. agrees with the formula of pholerite: Al_2O_3, $SiO_3 + 2$ HO; No. II. with the formula 3 Al_2O_3, 4 SiO_3 + 12 HO; No. III. after deduction of 3·2 per cent of amorphous silicic acid, and of 10·55 per cent of water which is expelled at 100°, gives the formula RO, 3 SiO_3 + 4 (R_2O_3, 2 SiO_3) + 16 HO. If, as assumed, RO, 3 SiO_3 is merely an admixture, the formula R_2O_3, 2 SiO_3 + 4 HO is obtained. No. IV. yields the formula 2 Al_2O_3, 5 SiO_3 + 6 HO.

Respecting the composition of various kinds of clay found in England, comp. II, 309.

Amorphous Silicate of Sesquioxide of Iron.—Starting from the assumption that chloropal, nontronite, and other allied silicates of sesquioxide of iron, are mixtures of silicates of a constant composition with amorphous silicic acid, Kobell(5) has investigated, I. a new chloropal, from Haar, near Passau; II. a specimen from Hungary; III. nontronite from Andreasberg. The first is met with in pistachio-green lumps intermixed with opal, which occur together

(1) Rammelsb. Handwörterb. 3. Suppl. 117.

(2) Verhandl. Rheinl. Naturh. Verein, 1848, 41; Jahrb. Miner. 1848, 569.

(3) Ann. Ch. Phys. [3] XXI, 376; J. Pr. Chem. XLII, 454; Jah rb. Mincr. 188, 585.

(4) Jahrb. Miner. 1848, 785.

(5) J. Pr. Chem. XLIV, 95; Munch. Gel. Anz. XXVI, 543.

Amorphous silicate of sesquioxide of iron.

on the upper side of a stratum of graphite. In concentrated solution of potassa it assumes a dark ochre-brown colour which, according to Kobell, is characteristic of all the chloropals. They are slowly decomposed by hydrochloric acid with separation of gelatinous SiO_3 in the form of powder, and invariably contain the Fe as Fe_2O_3. In order to separate the amorphous SiO_3, the powdered minerals were boiled with potassa, until pulverized opal (from Haar) employed in a counter experiment was dissolved. I. a, and II. a, give the composition of the original mineral; I. b, II. b, and III. b, the composition after treatment with solution of potassa:

	SiO_3.	F_2O_3.	Al_2O_3.	CaO.	MgO.	HO.	Insoluble.	Total.
I. a.	80·66	9·74	1·03	—	—	5.33	2·66	99·42
II. a.	70·00	14·25	0·75	—	—	15·00	—	100·00
I. b.	52·10	40·60	3·00	1·60	1·08	—	—	98·38
II. b.	52·33	43·34	2·32	0·93	0·73	—	—	99·65
III. b.	49·00	46·00	—	—	—	—	—	—

The oxygen of R_2O_3 and SiO_3 is found to be in I. b = 1 : 2·03, in II. b = 1 : 1·96, and in III. b = 1 : 1·188; hence Kobell assumes the silicate which is contained in chloropal to be, in the anhydrous condition Fe_2O_3, 2 SiO_3, to which he adds 3 equivs. of the water, the trifling excess being assigned to the opal which is mixed with it. Since chloropal and nontronite exhibit a similar chemical deportment they can no longer be considered as distinct species; Kobell also regards pinguite as an allied mineral.

Hydrated Silicates with Bases RO. Zinc-Glass. — Monheim(1) has investigated very pure zinc-glass (zinonise), from the Altenberg, near Aix-la-Chapelle, (spec. grav. from 3·43 to 3·49); I. perfectly transparent; II. somewhat milky; III. a specimen from Rezbanya. The investigation was undertaken chiefly with the view of correcting the discrepant statements respecting the amount of water.

	SiO_3.	ZnO.	Fe_2O_3.	HO.	CO_2.	Total.
I.	25·40	67·05	—	7·47	0·31	100·23
II.	24.31	65·74	0·43	7·51	0·31	98·30
III.	25·34	67·02	0·68	7·58	0·35	100·97
Calculation	25·08	67·44	—	7·48	—	100·00

The correct formula is accordingly 2 (3 ZnO, SiO_3) + 3 HO, as adduced by Berzelius, which requires the theoretical numbers given in the above statement. Monheim is of opinion, that the ZnO originally existed in solution in the form of carbonate, and that the

(1) Verhandlungen des naturhistorischen Vereins der Preuss. Rheinl. 1848, 157.

Apophyllite. zinc-glass was formed by the reciprocal action of the former upon the alkaline or earthy silicates. According to his experiments zinc-glass is soluble to a considerable extent and without decomposition in water impregnated with carbonic acid.

Apophyllite.—Rammelsberg(1) has analysed apophyllite from the gabbro of the Radau Valley, near the Hartz. Spec. grav. = 1·961.

SiO_3.	CaO.	KO	Fluosilicate.	HO.	Total.
52·44	24·61	4·75	1·43*	16·73	99·96

* Containing 0·46 Fl.

Hydrated Silicates with Bases RO and R_2O_3. Chlorastrolite.—Whitney(2) has given the name chlorastrolite to a new species of zeolite from Kewenaw Point and Isle Royal, Lake Superior. It occurs in bluish-green, iridescent masses of radiated fibrous structure, having a pearly lustre upon the planes of fracture. Hardness = 5·5 to 6. Spec. grav. = 3·18. Before the blow-pipe it intumesces, and readily fuses to a greyish vesicular glass. It is decomposed with facility by hydrochloric acid, and, according to Whitney, may be considered as zoisite + 3 HO = 3 RO, SiO_3 + 2 R_2O_3, SiO_3 + 3 HO.

	SiO_3.	$\frac{6}{7}Al_2O_3$.	$\frac{1}{7}Fe_2O_3$.	$\frac{6}{7}$CaO.	$\frac{1}{7}$NaO.	KO.	HO.	Total.
Found . .	36·99	25·49	6·48	19·90	3·70	0·40	7·22	100·18
Calculated	38·25	24·32	6·31	19·97	3·70	—	7·45	100·00

Scolezite.—Gibbs(3) has analysed a specimen of scolezite from Iceland, crystallized in transparent needles. The composition agrees with the formula adduced by Rose, CaO, SiO_3 + Al_2O_3, SiO_3 + 3 HO.

	SiO_3.	Al_2O_3.	CaO.	HO.	Total.
Found . . .	46·72	25·90	13·71	13·67	100 0
Calculated . .	45·99	26·09	14·21	13·71	100·0

Chabasite.—Engelhardt(4) and Genth(5) have investigated the chabasite which is found in quantity on the arable land originally formed from the vesicular basalt in the vicinity of Annerod, near Giessen(6). It is milk-white, and only translucent.

(1) Rammelsb. Handw. 3. Suppl. 18.
(2) Jour. Bost. Soc. Nat. Hist. V, 486; Sill. Am. J. [2] VI, 270 (in abstr.)
(3) Pogg. Ann. LXXI, 559; J. Pr. Chem. XLII, 458.
(4) Ann. Ch. Pharm. LXV, 370; J. Pr. Chem. XLV, 458.
(5) Ann. Ch. Pharm. LXVI, 274; J. Pr. Chem. XLV, 458.
(6) The crystals have the form of phacolite: twin crystals of R . $-\frac{1}{2}$R . $\frac{2}{3}$ P2.

Chabasite.

Engelhardt	SiO_3.	Al_2O_3.	Fe_2O_3.	CaO.	MgO.	KO.	NaO.	HO.	Total.
a.	48·31	19·47	0.14	11·00	0·26	1·17	—	19·65	100·00
b.	48·43	19·72	—	10·82	—	—	—	—	—
Genth	47·00	19·71	0·15	10·63	—	0·33	0·65	22·29	100·76
Calculated	47·52	20·22	—	11·02	—	—	—	21·24	100·00

Engelhardt had dried the mineral at 100°, by which means it lost on the average 4·72 per cent = 3 equivs. of water. Of the remainder, $\frac{1}{5}$ was united with greater force, being expelled only at a dull red-heat.—If we calculate from Engelhardt's numbers the composition of the mineral dried in the air, we obtain 23·27 per cent of water, and 46·13 per cent of silicic acid, agreeing, together with Genth's analysis, approximately with the formula adduced by Berzelius: 3 RO, 2 SiO_3 + 3 (Al_2O_3, 2 SiO_3) + 18 HO (comp. calculation). The excess of water and loss of silicic acid is explained, as the appearance demonstrated, by the somewhat decomposed state of the mineral. Engelhardt has calculated the formula RO, SiO_2 + Al_2O_3, 3 SiO_2 + 5 HO, and Genth, the formula 3 RO, 2 SiO_3 + 3 (Al_2O_3, SiO_3) + 18 HO.

Faujasite.—Damour(1) has repeated the analysis of faujasite, with a larger quantity of material than had been at his disposal in his first experiment.

	SiO_3.	Al_2O_3.	CaO.	NaO.	HO.	Total.
Found . . .	46·12	16·81	4·79	5·09	27·09	99·90
Calculated	45·64	17·26	4·70	5·20	27·20	100·00

These numbers lead to the ratio of oxygen of RO : R_2O_3 : SiO_3 : HO = 1 : 3 : 9 : 9, and to the formula ($\frac{1}{2}$CaO, $\frac{1}{2}$NaO), SiO_3 + Al_2O_3, 2 SiO_3 + 9 HO, according to which faujasite has a composition similar to that of the silicious chabasites, containing, however, only about half the amount of water.—Genth(2) has found this rare mineral, accompanied by chabasite and phillipsite, in the vesicular basalt, near Annerod, in the vicinity of Giessen.

Phillipsite. (Christianite).—Descloizeaux(3) has measured small transparent crystals of phillipsite from the trap-amygdaloid, of the Bay of Dyrefiord, in Iceland. They presented rhombic combinations of $\infty \breve{P} \infty . \infty \bar{P} \infty . \breve{P} \infty . P$; in isolated crystals Pn was observed. The measured angles are: $\breve{P} \infty : \infty \breve{P} \infty = 124^0\,22'$; $\breve{P} \infty : P = 147^0\,30'$; $\breve{P} \infty = 111^0\,15'$; $P : \infty \bar{P} \infty = 122^0\,30'$; $P : P = 123^0\,7'$ (in the brachydiagonal principal section), and $\breve{P}n : \infty \bar{P} \infty = 138^0\,54'$. The

(1) Ann. des Min. [4] XIV, 67.
(2) Ann. Ch. Pharm. LXVI, 274.
(3) Compt. Rend. XXV, 712; Ann. Ph. Nat. VI, 238; J. Pr. Chem. XLV, 455.

Phillipsite. Christianite.

two first angles gave: principal axis: macrodiagonal: brachydiagonal $= 1 : 1{\cdot}461 : 1{\cdot}295$; $P : P = 123^0\ 7'$ in the brachydiagonal principal section, $115^0\ 0'$ in the macrodiagonal principal section, and $91^0\ 46'$ in the base; $\breve{P}\infty = 111^0\ 16'$ in the brachydiagonal principal section; $\bar{P}\infty = 104^0\ 40'$ in the macrodiagonal principal section; $\infty P = 96^0\ 53'$ in the brachydiagonal principal section.—From the latter angle we arrive at $\breve{P}n = \breve{P}\frac{1}{2}$ (Descloizeaux has calculated $\frac{2}{5}$), which has not hitherto been observed. These measurements differ, although not very considerably, from those of Naumann(1) and of Haidinger(2).

Genth(3) has analysed phillipsite, from the Stempel, near Marburg. Small macled crystals of the form $\infty\breve{P}\infty . \infty\bar{P}\infty . P$; they were much cracked, and of a yellowish-white colour.

SiO_3.	Al_2O_3.	Fe_2O_3.	CaO.	KO.	NaO.	HO.	Total.
48·17	21·11	0·24	6·97	6·61	0·63	16·62	100·35

The ratio of oxygen of $RO : R_2O_3 : SiO_3 : HO = 1 : 3{\cdot}04 : 7{\cdot}82 : 4{\cdot}5$, is the same as that calculated by Rammelsberg(4), from Connel's analysis of the mineral from the Riesendamm. The state of the crystals, however, indicated the commencement of disintegration, and hence the amount of water may be assumed to be somewhat higher. If so, the analysis agrees with the formula adduced by Rammelsberg: 3 RO, 2 SiO_3 + 3 (Al_2O_3, 2 SiO_3) + 15 HO.

Descloizeaux and Dufrénoy(5) again separate phillipsite into two species, in consequence of Marignac(6) having found the above ratio of oxygen $= 1 : 3 : 6 : 3\frac{1}{2}$ for the mineral obtained from Vesuvius, to which Levy originally had assigned the name phillipsite. Under the latter term are included the varieties from Vesuvius, from Aci Reale, and from the Capo di Bove. The varieties from Marburg, Annerod, and from Iceland, are termed by Descloizeaux christianite.

Gismondine.—Distinct and brilliant crystals of gismondin, from the Capo di Bove, have been obtained by Credner(7) through M. de Medicis Spada of Rome, from whom also Kobell received the materials of his analysis. According to his observations they do not

(1) Lehrb. 1. Aufl. 371.
(2) Handbuch der bestimmenden Miner. 527.
(3) Ann. Ch. Pharm. LXVI, 272; J. Pr. Chem. XLV, 459.
(4) Handw. 2. Suppl. 60; 3. Suppl. 50.
(5) Traité de Minéralogie, III, 449. 478.
(6) Ann. Ch. Phys. [3] XIV, 44.
(7) Jahrb. Miner. 1847, 559.

belong to the tetragonal, but to the rhombic system, and exhibit for the most part a twin formation with crossed principal axes, as observed by Wernekinck in the baryta-harmotome from the Schiffenberg, near Giessen(1). The individual crystals are combinations of $\infty \breve{P} \infty . \infty \bar{P} \infty . P$. Hence Credner regards gismondine and phillipsite as identical, and refers in this respect to the accordance of Marignac's analysis of phillipsite from Vesuvius(2), with Kobell's analysis of gismondine from the Capo di Bove(3); the former, however, gives the ratio of oxygen in $RO : R_2O_3 : SiO_3 : HO = 1 : 3 : 6 : 3\frac{1}{2}$, while the latter yields the ratio $= 1 : 4 : 7 : 5$.—It is much to be regretted that no statements are made with respect to the angles. Gismondine.

Diaphanite. Neolite.—Nordenskiöld's investigation of diaphanite, communicated at an earlier period(4), has now been published with more details(5); as also(6) the earlier examination(7) of neolite by Scheerer.

Gigantolite.—Marignac(8) has investigated gigantolite from Tammela. Spec. grav. = 2·871. It exhibits planes of exfoliation in the direction of 0 P, but no actual planes of cleavage. (I. was decomposed by NaO, CO_2; II. by HFl).

	SiO_3.	Al_2O_3.	FeO.	MnO.	MgO.	KO.	NaO.	HO.	Total.
I.	42·59	26·78	14·21	1·07	2·74	—	—	5·70	—
II.	—	26·47	14·10	0·83	2·54	5·44	0·86	6·08	—
Mean	42·59	26·62	14·16	0·95	2·63	5·44	0·86	5·89	99·14

Marignac has calculated the ratio of oxygen contained in $RO : R_2O_3 : SiO_3 : HO = 1 : 2 : 4 : 1$, and adduced the formula $3\,RO, 2\,SiO_3 + 2\,(Al_2O_3, SiO_3) + 3\,HO$; he obtained accordingly about half as much more HO and RO than Trolle-Wachtmeister, who found the above ratio to be $= 1 : 3 : 6 : 1$, and arrived at the formula $RO, SiO_3 + Al_2O_3, SiO_3 + HO$. Marignac remarks that his formula exactly agrees with that of ottrelite according to Damour's analysis, with the difference only, that in the latter RO = FeO and MnO. He perceives in this analogy a strong support

(1) Gilbert's Ann. LXXVI, 171. 336.
(2) Ann. Ch. Phys. [3] XIV, 41.
(3) J. Pr. Chem. XVIII, 105; comp. Rammelsberg's Handwörterb. II, 290 and 3. Suppl. 51.
(4) Petersb. Acad. Bull. V, 266; Berzelius' Jahresber. XXVII, 234 (in abstr.)
(5) Pogg. Ann. LXX, 554.
(6) Pogg. Ann. LXXI, 285 comp. Rammelsb. Handw. 3. Suppl. 86.
(7) Oefversigt af K. V. Acad. Förh. IV, 70; Berzelius' Jahresber. XXVII, 251.
(8) Arch. Ph. Nat. IV, 159.

Chlorophyllite.

for Alger's view, that gigantolite and ottrelite together with phyllite(1) belong to one species.

Chlorophyllite.—Rammelsberg(2) has analysed a specimen of chlorophyllite from Unity, New Hampshire. Spec. grav. 2·782. Hydrochloric acid extracts from it a portion of sesquioxide, but no protoxide of iron; the other constituents are either not at all, or only slightly attacked.

SiO_3.	Al_2O_3.	Fe_2O_3.	MgO.	CaO.	HO.	Total.
46·31	25·17	10·99	10·91	0·58	6·70	100·66

Assuming that the mineral, like cordierite, contains a portion of the iron in the form of protoxide (1·35 FeO and 9·50 Fe_2O_3), Rammelsberg has calculated the formula 3 RO, 2 SiO_3 + 3 (R_2O_3, SiO_3) + 4 HO; accordingly this mineral is cordierite which in its metamorphosis has assimilated 4 equivs. of water.

Pinite.—Rammelsberg(3) has investigated I. bluish-grey pinite, with a red, micaceous coating, from Penig; and likewise, II. a specimen covered with unaltered mica, from Aue, near Schneeberg. Marignac(4) has examined, III. light-grey pinite, from Auvergne (spec. grav. = 2·74); IV. a greenish-grey specimen from Saxony (spec. grav. = 2·75), and V. a blackish-green variety from Mont Brevent, near Chamouny; (spec. grav. = 2·84). The three latter specimens appeared to be slightly decomposed. In thin splinters translucent; fracture homogeneous, not earthy, and of somewhat resinous lustre.

	SiO_3.	Al_2O_3.	FeO.	CaO.	MgO.	KO.	NaO.	HO.	Total.
I.	47·00	28·36	7·08	0·79	2·48	10·74	1·07	3·83	101·35
II.	46·83	27·65	7·84	0·49	1·02	6·52	0·40	7·80	98·35
III.	47·50	31·80	3·92	—	1·78	9·05	0·92	5·03	100·00
IV.	46·10	32·46	4·27	—	2·26	9·00	0·46	5·45	100·00
V.	44·70	31·64	6·57	—	2·86	7·89	0·95	5·39	100·00

Rammelsberg's analysis was made with the view of establishing the relation of pinite to cordierite. From I. he arrived at the formula 3 RO, 2 SiO_3 + 3 (Al_2O_3, SiO_3) + 2 HO; he considers this specimen of pinite as bonsdorffite or cordierite + 2 HO. From II. he calculated the formula 3 (RO, SiO_3) + 4 (Al_2O_3, SiO_3) + 6 HO = 3 RO, 2 SiO_3 + 3 (Al_2O_3, SiO_3) + Al_2O_3, 2 SiO_3 + 6 HO = aspasio-

(1) Thomson's Miner. I, 238; Dufrénoy's Miner. III, 592.
(2) Rammelsb. Handw. 3. Suppl. 34.
(3) Rammelsberg's Handwörterb. 3. Suppl. 94.
(4) Arch. Ph. Nat. VI, 157; J. Pharm. [3] XII, 151 (in abstr.)

lite + HO.—Marignac has adopted the formula 3 (RO, SiO_3) + 4 (Al_2O_3, SiO_3) + 4 HO. Liebenerite.

Liebenerite.—Marignac(1) has analysed liebenerite from Monte Viesena in the Flems-Valley. Hexagonal (?) prisms of bright, greenish-grey colour. Hardness = 3·5. Spec. grav. = 2·814. Fusible only at the edges. Imperfectly decomposed by hydrochloric acid with evolution of a small quantity of carbonic acid. I. was decomposed by means of NaO, CO_2; II. and III. by the aid of H Fl.

	SiO_3.	Al_2O_3.	FeO.	MgO.	KO.	NaO.	HO and CO_2.	Total.
I.	45·03	36·42	1·70	1·54	—	—	—	—
II.	44·19	36·77	1·71	1·39	9·79	1·00	5·15	100·0
III.	44·76	36·34	1·83	1·27	10·00	0·84	4·96	100·0

These analyses give exactly the ratio of oxygen contained in RO : R_2O_3 : SiO_3 : HO = 1 : 6 : 8 : 1·5, leading to the formula 3 RO, 2 SiO_3 + 6 (Al_2O_3, SiO_3) + 5 HO.—Oellacher(2) has proposed the formula RO, 2 SiO_3 + 3 (Al_2O_3 SiO_3) + 3 HO which assumes the ratio of oxygen $\frac{2}{3}$: 6 : 10 : 2. Marignac is inclined to class this mineral with pinite, whilst Haidinger(2), Breithaupt(3), and Blum(4), represent it as a pseudomorph, imitative of nepheline.

Palagonite.—Sartorius von Waltershausen(5) has found, in Iceland, remarkably pure palagonite, a mineral discovered by him at an earlier period in Sicily. It has been analysed and described by Bunsen(6). Amorphous; fracture uneven, and conchoidal when in small pieces. Hardness somewhat below 5; easily frangible; in thin splinters translucent; lustre vitreous, inclining to waxy; colour coffee-brown in reflected, and honey-yellow in transmitted light. Spec. grav. = 2·429. Heated in a flask it yields water, fuses readily before the blow-pipe to a magnetic bead, and is easily decomposed by dilute acids. I. from Seljadalr.; II. from the Selsund chain; I. a. and I. b. are the two preceding analyses, after deduction of the hygroscopic water and the insoluble constituents :

(1) Arch. Ph. Nat. VI, 293; J. Pharm. [3] XIII, 290 (in abstr.)
(2) Haidinger's Handb. d. best. Miner. 518; the same author's Uebersicht d. Mineral. Forschungen, 1843, 36.
(3) Breithaupt, Handb. der Mineralogie, III, 475.
(4) Blum's Pseudomorphosen, Nachtr. 24.
(5) Göttinger Studien, 1845, 402.
(6) Ann. Ch. Pharm. LXI, 265.

Pala-gonite.

	SiO_3.	Fe_2O_3.	Al_2O_3.	CaO.	MgO.	KO.	NaO.	HO.	Hygrosc. HO.	Insoluble matter.	Total.
I.	37·417	14·175	11·165	8·766	6·036	0·685	0·652	17·152	—	4·108	100·156
II.	32·911	12·865	8·925	7·548	4·244	0·995	1·283	14·636	7·102	9·573	100·082
I. a.	38·952	14·758	11·624	9·126	6·284	0·713	0·678	17·858	—	—	100·000
I. b.	39·459	15·424	10·701	9·049	5·088	1·193	1·538	17·548	—	—	100·000

Bunsen gives the formula 3 (MgO, CaO, KO, NaO), 2 SiO_3 + 2 [(Fe_2O_3, Al_2O_3), SiO_3] + 9 HO, and remarks, that this mineral, like ottrelite, may be regarded as a hydrated variety of scapolite.

Hisingerite.—Hisingerite, I. from Riddarhyttan, and II. from the Gillinge Mine, in Södermanland, has been examined by Rammelsberg(1). No. II. was infusible; No. I. however, fused to a black, magnetic slag, owing to the presence of a quantity of iron pyrites with which it was contaminated. Analysis gave (in the case of I., after deduction of 24·99 per cent of Fe S_2, and 2·32 per cent of Cu_2 S):

	SiO_3.	Fe_2O_3.	FeO.	CaO.	MgO.	HO.	Total.	
I. a.	33·07	34·78	17·59	2·56	0·46	11·54	100·0	Found.
b.	30·06	34·76	23·46	—	—	11·72	100·0	Calculated.
II. a.	32·18	30·10	8·63	5·50	4·22	19·37	100·0	Found.
b.	28·40	32·83	22·16	—	—	16·61	100·0	Calculated.

For I. Rammelsberg has calculated the formula 3 FeO, SiO_3 + 2 (Fe_2O_3, SiO_3) + 6 HO; No. II. gives the same formula with 9 equivs. of HO.

Silicates with Hydrates. Minerals allied to Schiller-Spar. Williamsite.—Two minerals probably allied to schiller-spar have been investigated: I. by Rammelsberg(2), and II. by Shepard(3). No. I. found by Zincken in the Radau-Valley; compact, green, and unctuous to the touch. Spec. grav. = 2·76.—No. II. found by Williams at Texas, Lancaster County, in Pennsylvania, and named after the discoverer; it occurs in irregularly-shaped seams, sometimes above an inch in thickness, between serpentine and chrome iron-stone. It is analogous to diallage, compact, foliaceous, slightly nacreous, apple-green, and translucent. Spec. grav. from 2·59 to 2·64. It is slowly decomposed by hydrochloric acid.

	SiO_3.	Al_2O_3.	FeO.	MgO.	HO.	Total.
I.	41·48	6·49	16·61	27·24	10·13	101·95
II.	45·40	8·50	—	33·60	12·50	100·00
Calculation for II.	46·06	8·52	—	33·42	11·96	100·00

(1) Pogg. Ann. LXXV, 308.
(2) Rammelsb. Handw. 3. Suppl. 106.
(3) Sill. Am. J. [2] VI, 249.

By calculating the SiO_3 and Al_2O_3 together, the analysis of the former, according to Rammelsberg, leads to the formula assigned by Kobell to schiller-spar.—For the latter, Shepard calculates the expression 3 (MgO, $1\frac{1}{2}$ SiO_3) + Al_2O_3, SiO_3 + 3 HO. Here an error of calculation has evidently crept in. The analysis agrees far better with the formula 5 (2 MgO, SiO_3) + Al_2O_3, SiO_3 + 8 HO (comp. calculation), according to which the mineral might be classed with pyrosclerite.

Serpentine. (Picrolite and Chrysotile).—The following minerals allied to serpentine have been investigated:

I. Bluish-green fibrous picrolite from Texas, County of Lancaster, in Pennsylvania, accompanied by magnesite. Spec. grav.= 2·557, by Rammelsberg(1).

II. A greyish-green, translucent, foliaceous mineral from Villa Rota, on the River Po. Nacreous on the planes of separation, and unctuous to the touch. Readily decomposed by hydrochloric acid; spec. grav. = 2·644; difficultly fusible. Analysed by Delesse(2).

III. This mineralogist(3) has likewise investigated fibrous chrysotile from the serpentine of Goujot, near Eloyes, Vosges. Spec. grav. 2·219.

IV. Leek-green, fibrous chrysotile from the serpentine of Zöblitz. Spec. grav.=2·60 to 2·65. Difficultly fusible. By Schmidt(4).

	SiO_3.	Al_2O_3.	FeO.	MgO.	NaO.	HO.	Total.
I.	43·79	—	2·03	41·03	—	12·47	99·32
II.	41·34	3·22	5·54	37·61	—	12·06	99·77
III.	41·58	0·42	1·69	42·61	—	13·70	100·00
IV.	43·70	2·76	10·03	29·96	1·98	12·27	100·70

Rammelsberg has deduced from his analysis I. the ratio of oxygen contained in RO : SiO_3 (+Al_2O_3) : HO = 9 : 12 : 6, and has pointed out that 12 other trustworthy analyses of serpentine, and of allied minerals give nearly the same ratio of oxygen. Accordingly he adduces the formula 2 [(3 MgO, 2 SiO_3) + 3 HO] + 3 (MgO, HO), which to a certain extent is supported by analysis No. III., since the latter yields the above ratio = 9·4 : 12 : 6·6.—The ratio for No. II. and for No. IV. is calculated = 8·5 : 12 : 5·6, and = 7·1 : 12 : 5·3.—Delesse assigns to No. II. the formula $(RO)_3$, SiO_3 [respecting (RO) comp. II. 379], and Schmidt the formula 3 RO, 2 SiO_2 + 2 HO for No. IV.

(1) Handw. 3. Suppl. 108.

(2) Ann. des Mines. [4] XIV, 78; Arch. Ph. Nat. VI, 111; Jahrb. Miner. 1848, 658.

(3) Arch. Ph. Nat. VII, 116.

(4) J. Pr. Chem. XLV, 14.

Steatitic minerals. Imitative-garnet pseudomorph.

Steatitic Minerals. Imitative-Garnet Pseudomorph.—Hermann(1) has examined a specimen of greenish steatite, occurring in nests, and also as a pseudomorph, imitative of garnet and epidote (?) in the talc-slate of the Schischimskaja-Gora. Spec. grav.=2·50. Heated over a spirit-flame it yields little or no water, but in the fire of a forge it gives off 13·4 per cent.

SiO_3.	Al_2O_3.	Fe_2O_3.	MgO.	HO.	Magnet. iron and insol. matter.	Total.
25·60	22·21	5·00	30·96	13·43	2·25	99·45

The oxygen contained in SiO_3, Al_2O_3 and Fe_2O_3, MgO and HO stands as 1·106 : 0·968 : 1 : 0·973 ; consequently = 1 : 1 : 1 : 1. Hermann therefore adopts the formula of Snarum steatite, as calculated by Rammelsberg from the analyses made by Hochstetter and Giwartowsky(2), but with double the amount of R_2O_3, namely 3 MgO, SiO_3 + 2 Al_2O_3, SiO_3 + 3 (MgO, 2 HO).

Imitative-Pleonaste Pseudomorph.—Closely allied to the former appears to be the steatitic mineral which is found on the Monzoni Hill, in the Fassa-Valley, where it occurs as a pseudomorph, imitative of pleonaste. It has been investigated by Marignac(3). His analysis differs considerably from that of Stadler, both in the amount of silicic acid and of water, from which it appears that the mineral has no definite composition.

SiO_3.	Al_2O_3.	Fe_2O_3.	Mn_2O_3.	MgO.	CaO.	HO.	Total.	
31·10	17·50	2·76	—	29·69	5·56	13·67	100·28	Marignac.
37·50	15·70	4·60	1·70	25·80	8·70	6·00	100·00	Stadler.

According to Marignac's analysis the ratio of oxygen contained in RO : R_2O_3 : SiO_3 : HO = 13 : 9 : 16 : 12, from which we may deduce [3 RO, 2 SiO_3 + 3 (R_2O_3, SiO_3) + 2 HO] + 10 (MgO, HO), or in reference to the origin of the mineral perhaps better the formula 6 RO, 5 SiO_3 + 3 (Al_2O_3, MgO + 4 (MgO, 3 HO) ? Hence the mineral would appear still to contain a portion of spinel.

Brandisite.—A dealer in minerals, of the name of Augustin, has discovered upon the Monzoni Hill a new micaceous mineral, to which Liebener has given the name brandisite, and Breithaupt the term disterrite (δι στερρός doubly hard). It has been described by

(1) J. Pr. Chem. XL, 17.

(2) J. Pr. Chem. XVII, 377 ; Berzelius' Jahresber. XXIII, 280 ; Rammelsb. Handw. 1. Suppl. 140 and 3. Suppl. 116.

(3) Arch. Ph. Nat. VI, 302.

Haidinger(1), and analysed by Kobell(2). Small, inflexible, hexagonal tables: 0 P. ∞ P; perfectly, though difficultly cleavable in the direction of 0 P. Hardness upon 0 P = 5, upon ∞ P = $6\frac{1}{4}$ to 6·5 (Kobell), extremely brittle. Nacreous upon 0 P; in thin leaves, highly translucent, optically uniaxial. Colour leek-green, becoming reddish-grey by disintegration. Spec. grav. = 3·015 to 3·062. Infusible before the blow-pipe; decomposed by boiling sulphuric, but not attacked by hydrochloric acid. The freshest fragments that it was possible to obtain gave on analysis: Brandisite.

	SiO_3.	Al_2O_3.	Fe_2O_3.	CaO.	MgO.	KO.	HO.	Total.
Found . .	20·00	43·22	3·60	4·00	25·01	0·57	3·60	100·00
Calculated .	19·89	45·00	—	—	31·04	—	3·95	100·00

besides traces of Mn_2O_3, CuO and Cl. Kobell proposes the formula 4 (MgO, Al_2O_3) + 3 (RO), 2 SiO_3, in which (RO) = MgO, CaO and HO(3). If the HO be placed outside the parenthesis, the formula will then be = 4 (MgO, Al_2O_3) + 3 RO, 2 SiO_3 + 2 HO, which requires the above calculated percentage.—According to Kobell the formula receives additional support from the fact of the mineral occurring together with pleonaste and with augite.

Chlorite. (Leuchtenbergite; Ferruginous Chlorite).—Hermann(4) had pointed out that the leuchtenbergite classed by Komonen as a distinct species, might possibly be nothing but chlorite, since it agreed with this mineral both in its external appearance and chemical properties, excepting the amount of water it contains which was found by Komonen to be too low, namely 8·68 per cent instead of 12·91.—Hermann's view has now been fully confirmed by two new analyses of leuchtenbergite. I. by Hermann(5), II. by Marignac(6). According to the former observer this mineral does part with its water completely, except when exposed, in the form of fine powder, to the fire of a forge for half-an-hour.

By analysing a silver-white, crystallised (0 P . P . ∞ P) chlorite, of the spec. grav. 2·603, obtained from the neighbourhood of the River Iremel, in the district of Slatoust, Hermann has, at the same time, endeavoured to decide the question as to whether the iron contained in chlorite exists in this mineral as protoxide or as sesquioxide.

(1) Haidinger's Berichte (comp. II, 379,) I, 4 and II, 349.
(2) J. Pr. Chem. XLI, 154; Jahrb. Miner. 1848, 575 (in abstr.); Arch. Ph. Nat. VI, 60.
(3) In reference to (RO) comp. II, 379.
(4) J. Pr. Chem. XXXI, 99.
(5) J. Pr. Chem. XL, 13.
(6) Arch. Ph. Nat. IV, 162.

Chlorite. (Leuchtenbergite; ferruginous chlorite).

In comparison with the analyses of green chlorite, III. exhibits for the small amount of iron a correspondingly large proportion of magnesia, whence Hermann justly concludes that the iron contained in chlorite must chiefly be in the form of protoxide, proving the correctness of Varrentrapp's formula 3 (MgO, FeO), SiO_3 + Al_2O_3 + 2 MgO, 2 HO.

A green mineral with parallel fibres, probably allied to the above, and obtained from the cellular cavities of the porphyry of La Grève, in the Vosges, has been analysed (IV.) by Delesse(1). Voltz had with some reserve proposed the name picrolite for this mineral. Hardness from 2 to 2·5. Spec. grav. = 2·89. Fusible before the blow-pipe, but only at the edges, to a black magnetic slag. Readily decomposed by acids, both before and after ignition, with separation of silicic acid.

	SiO_3.	Al_2O_3.	Fe_2O_3.	FeO.	MgO.	CaO.	HO.	Total.
I.	32·35	18·00	—	4·37	32·29	—	12·50	98·51
II.	32·23	14·76	—	7·25	30·76	4·02	11·39	100·41
III.	30·80	17 27	1·37	—	37·08	—	12·30	98·82
IV.	31·07	15·47	17·54	4·07	19·14	0·46	11·55	99·30

If we assume the iron in the latter mineral, which Delesse has termed ferruginous chlorite (*chlorite ferrugineux*), to exist as protoxide, the ratio of oxygen contained in SiO_3 : Al_2O_3 : RO : HO : = 6·70 : 3 : 4·89 : 4, hence it differs from that of chlorite merely by an excess of 0·7 of silicic acid.

Green-Earth.—Delesse(2) has investigated the green-earth from the Monte Baldo, near Verona. Under the microscope it is found to consist of small, irregular granules. The statement of Berthier respecting its decomposition by continued digestion with hydrochloric acid has been confirmed by the experiments of Delesse. The iron which it contains was proved to be in the form of protoxide by means of terchloride of gold. The presence of chromium could not be detected. Spec. grav. = 2·907. Composition:

SiO_3.	Al_2O_3.	FeO.	MnO.	MgO.	KO.	NaO.	HO.	Total.
51·25	7·25	20·72	trace	5·98	6·21	1·92	6·67	100·00

from which Delesse has calculated the formula 8 RO, SiO_3 + Al_2O_3, SiO_3 + 6 HO.

(1) Mém. de la Soc. d'Emulat. du Doubs, 1847; Arch. Ph. Nat. V, 262; J. Pr. Chem. XLIII, 429.

(2) Ann. des Mines [4] XIV, 74; Arch. Ph. Nat. VIII, 106; Jahrb. Miner. 1848, 545.

Silicates with Fluorides. Humite.—Marignac(1) has measured with the reflective-goniometer and analysed small, highly lustrous, yellow crystals of humite, exhibiting numerous planes, from Vesuvius. The mineral does not belong, he finds, as assumed by Dana and G. Rose, to the monoclinometric, but, in accordance with the statements of Phillips, to the rhombic system. Brachydiagonal: macrodiagonal: principal axis = 0·461 : 1 : 2·026. 0 P . $\breve{P}\infty = 116^0\,16'$; 0 P : $\bar{P}\infty = 102^0\,49'$. In the twin crystals the principal axes are inclined at an angle of 120°, in the direction of m $\bar{P}\infty$ (m = $\frac{1}{8}$?). Spec. grav. = 3·150. Analysis gave:

SiO_3.	MgO.	FeO.	Loss (Fl.)
30·88	56·72	2·19	10·21

Marignac considers, with Monticelli and Covelli, humite to be identical with chondrodite, and refers to the agreement of his measurements with those of Phillips, and also of his analysis with that of the American chondrodite by Rammelsberg(2). Although this identity is not improbable, it cannot be considered as proved by the above results, for Phillips' statements refer likewise to humite, whilst Rammelsberg's analysis gave an excess of 3 per cent of SiO_3. It still remains to be proved that chondrodite which, according to Dana, is monoclinometric, actually occurs in forms of the rhombic system.

Chondrodite.—According to Hermann(3), chondrodite occurs in compact, reddish-yellow masses as large as nuts, in the Schischimskaja-Gora, and in lustrous, highly translucent, rose-red crystals of the spec. grav. 3·10, at Achmatowsk. Availing himself of this communication, he changes Rammelsberg's formula: 2 (3 MgO, SiO_3) + Mg Fl to 2 (3 MgO, SiO_3) + MgO, Mg Fl, because the analyses of the latter mineralogist gave 4 per cent of SiO_3 less than the formula requires. He does not, however, mention that Rammelsberg himself had calculated the latter formula, but which he again rejected(2) in consequence of the old method of analysis employed giving too high an amount of iron, and too little silicic acid.

Silicates with Chlorides, Sulphates, and Carbonates. Sodalite. Noseane. Hauyne. Ittnerite. Cancrinite.—In the laboratory of H. Rose, Whitney(4) has investigated the following six minerals, and earned great credit by his beautiful researches into their chemical constitution.—I. Sodalite, from Litchfield, Maine in North America, where it occurs in detached blocks of granite, toge-

(1) Arch. Ph. Nat. IV, 152.
(2) Pogg. Ann. LIII, 130; Rammelsberg's Handw. 1. Suppl. 28.
(3) J. Pr. Chem. XL, 19.
(4) Berl. Acad. Ber. 1847, 39; Pogg. Ann. LXX, 431.

Silicates with chlorides, sulphates, and carbonates.

Sodalite. Noseane. Hauyne. Ittnerite. Cancrinite.

ther with zircon, cancrinite and elaeolite. Before the blow-pipe it instantly loses its beautiful sapphire-blue colour, and fuses to a clear vesicular glass. According to Whitney, the colour may perhaps depend upon the presence of ferric acid.—II. Noseane from the Lake of Laach. It becomes lighter before the blow-pipe, and fuses only at the edges.—III. Greenish-blue hauyne from the Albano Mountains, where it occurs in mica, together with vesuviane. It decrepitates violently on ignition, and fuses before the blow-pipe to a greenish-blue glass.—IV. Hauyne from Niedermendig.—V. Ittnerite. —VI. Two varieties of cancrinite from Litchfield: a. colour varying from sulphur- to lemon-yellow; (spec. grav. 2·448; hardness = 5·5 to 6]; b. colour varying from yellowish- to an asparagus-green tint; (spec. grav. 2·461; hardness = 5 to 5·5. Both varieties are hexagonal; cleavage remarkably perfect in the direction of ∞P, lustre vitreous, somewhat resinous; heated in a glass flask they lose water, and the whole of the carbonic acid, and yield before the blow-pipe, with intumescence, a clear, colourless glass. —All the minerals here mentioned, with the exception of ittnerite, form readily a clear solution, not only in dilute mineral acids, but even in some of the organic acids, e. g. in acetic, tartaric, and oxalic acids. When treated with concentrated acids they gelatinize, with the exception of cancrinite which, as Rose had previously pointed out, dissolves to a transparent solution, and gelatinizes only on ebullition, and then very suddenly. Hauyne only evolves hydrosulphuric acid on being dissolved, but in very minute quantity.

	SiO_3.	Al_2O_3.	Fe_2O_3.	KO.	NaO.	CaO.	Cl.	SO_3.	Loss on ignition.	Total.
I, 1.	37·30	32·88		0·59	23·86	—	6·97	—	—	101·60
2.	37·63	30·93	1·08	—	25·48	—	—	—	—	—
Calculation	37·21	31·66	—	—	25·47	—	7·29	—	—	101·63
II, 1.	36·52	29·54	0·44	—	23·12	1·09	0·61	7·66	1·37	100·35
2.	36·53	29·42	—	—	22·97	1·62	0·61	7·13	1·37	99·65
Calculation	36·65	30·59	—	—	24·82	—	—	7·94	—	100·00
III.	32·44	27·75	trace	2·40	14·24	9·96	trace	12·98	—	99·77
Calculation	32·46	27·09	—	—	16·49	9·88	—	14·08	—	100·00
IV, 1.	33 90	28·07	—	—	19·28	7·50	—	12·01	—	100·76
2.	34·83	28·51	0·31	—	18·57	7·23	—	12·13	—	101·58
Calculation	33·58	28·52	—	—	18·94	6·82	—	12·14	—	100·00
V.	35·69	29·14	—	1·20	12·57	5·64	1·25	4·62	9·83*	100·00

	SiO_3.	Al_2O_3.	Mn_2O_3.	Fe_2O_3.	CaO.	NaO.	KO.	CO_2.	HO.	Total.
VI, a, 1.	37·42	27·70	0·86	trace	3·91	20·98	0·67	5·95	2·82	100·31
2.	37·89	27·39	0·64	—	3·88	21·24		5·95	2·82	99·81
3.	37·84	28·26		—	3·82	20·94		5·95	2·82	99·53
VI, b.	37·20	27·59	0·27		5·26	20·46	0·50	5·92	3·28	100·48
Calculation	37·63	28·46	—	—	3·87	21·45	—	6·09	2·49	100·00

besides traces of chlorine. * water.

Cancrinite.

Whitney assigns to sodalite the formula previously adduced by Kobell, namely $3\,NaO,\,SiO_3 + 3\,(Al_2O_3,\,SiO_3) + NaCl$, and hence considers it as a compound of 1 equiv. of elaeolite, as represented by Gmelin's formula, with 1 equiv. of chloride of sodium. Noseane and hauyne from the Albano Mountains, likewise contain elaeolite, the former being a compound with 1 equiv. of $NaO,\,SO_3$, the latter with 2 equivs. of $CaO,\,SO_3$. Hauyne from Niedermendig, on the other hand, may be considered as a combination of 1 equiv. of noseane with 2 equivs. of Albano hauyne.—Whitney did not attempt to calculate a formula from his analysis of ittnerite, which closely agrees with that of Gmelin; Rammelsberg(1), however, pointed out that this mineral, closely allied to the foregoing both in its cleavage and in its general properties but differing in its amount of water, may be represented as a compound of 3 equivs. of (sodalite + 6 HO) + 10 equivs. of (Albano hauyne + 6 HO), the latter containing only half the quantity of $CaO,\,SO_3$.—The cancrinite from Litchfield, according to Whitney, is $[2\,NaO,\,SiO_3 + 2\,(Al_2O_3,\,SiO_3)] + (\frac{1}{2}\,NaO,\,\frac{1}{2}\,CaO),\,CO_2 + HO$, and therefore differs from the cancrinite of the Ilmen Mountains, according to Scheerer's formula, by the amount of water, and by the replacement of half the carbonate of lime by carbonate of soda.—The silicate it contains is elaeolite, according to the more recent formula of Scheerer.

Tourmaline.—Marignac(2) has measured small transparent crystals of tourmaline, probably from the Dauphiné; he found several planes which had not hitherto been observed. The crystals exhibited combinations of $+\frac{\infty P}{2}$, $-\frac{\infty P}{2}$, $\infty P\,2$ with $\frac{3}{4}\,R$, $-\frac{3}{2}\,R$ and 2 scalenhedrons, of which the one (n) truncates the combination-edges of the rhombohedron, the other (s), the edges of combination between $-\frac{3}{2}\,R$ and $\infty P\,2$.—The measurement yielded the polar edges of $\frac{3}{4}\,R = 143^0\,57'$, the same edges of $-\frac{3}{2}\,R = 116^0\,30'$; $\frac{3}{4}\,R : n = 168^0\,22'$, and $\frac{3}{4}\,R : s = 99^0\,45'$ (measured over n and $-\frac{3}{2}\,R$).

Titanates, Tantalates, &c. Wöhlerite.—On repeated investigation, Scheerer(3) has recognised the metallic acid contained in wöhlerite, which had formerly been considered as tantalic, and afterwards as niobic acid, as a mixture of niobic and pelopic acids. He believes that the mineral, like eucolite, contains moreover protoxide of cerium.

(1) Rammelsberg's Handwörterb. 3. Suppl. 59. (Comp. also p. 30 and 65).
(2) Arch. Ph. Nat. VI, 299.
(3) Pogg. Ann. LXII, 565.

Eucolite.

Eucolite.—Scheerer(1) has now quantitatively analysed the mineral occurring in the zircon syenite of Norway, and formerly(2) described under the name of "brown wöhlerite," which had been only qualitatively examined.

SiO_3	Metallic acid and zirconia.	Fe_2O_3.	CaO.	CeO.	NaO.	MnO.	MgO.	HO.	Total.
47·85	14·05	8·24	12·06	2·98	12·31	1·94	trace	0·94	100·37

In consequence of the zirconia being, to a considerable extent, replaced in this mineral by sesquioxide of iron, and the other principal constituents being met with in proportions differing from those of wöhlerite(3), Scheerer has been led to consider it as a distinct species which he terms eucolite. According to his observations, the metallic acid, formerly regarded as tantalic acid, is most probably a mixture of niobic and pelopic acids.

Enceladite.—Hunt(4) has described and analysed a new titaniferous mineral occurring at Amity, New York, imbedded in a white magnesian limestone, together with serpentine, ilmenite, spinel, and chondrodite. In its physical characteristics it resembles closely warwickite, with which it is associated(5).—Oblique rhombic prisms; colour bluish- or brownish-black, streak bluish. Lustre sometimes resinous, sometimes metallic; hardness = 3 to 4, and spec. grav. = 3·188. When heated in a flask it evolves water, and becomes lighter in colour. When heated in the atmosphere it assumes a brick-red colour; infusible; is slightly attacked by hydrochloric acid, and readily dissolved when gently warmed with sulphuric acid.

	SiO_3.	Fe_2O_3.	Ti_2O_3.	Al_2O_3.	MgO.	CaO.	HO.	Total.
1.	18·50	13·00	25·15	13·84	22·20	1·30	7·35	101·34
2.	18·00		51·81		23·11	1·36	6·82	101·10

Hunt proposes the formula $2\,(Fe_2O_3, Ti_2O_3, Al_2O_3) + 3\,MgO, SiO_3 + 2\,HO$, and considers the mineral to be metamorphosed titanic iron. Rammelsberg remarks, that it is the first hydrated titanic mineral with which we have become acquainted; he believes, however, that the titanium it contains exists in the form of titanic acid(6).

(1) Pogg. Ann. LXXII, 565.
(2) Pogg. Ann. LXI, 222; Berzelius' Jahresber. XXV, 375.
(3) Pogg. Ann. LIX, 327; Berzelius' Jahresber. XXIV, 289.
(4) Sill. Am. J. [2] II, 30; J. Pr. Chem. XLII, 453.
(5) Berzel. Jahresber. XIX, 294 and XX, 243.
(6) Rammelsb. Handw. 3. Suppl. 41.

Greenovite.

Greenovite.—Descloizeaux(1), unacquainted, as it appears, with Breithaupt's(2) investigation of greenovite, has likewise determined the crystalline form of this mineral. He has arrived at the result previously obtained by Delesse(3) and by Marignac(4) by means of chemical examination, that greenovite is a variety of sphene. His measurements essentially agree with those of sphene, made by G. Rose, by Levy, and by Phillips. The discrepant cleavage, exhibited in greenovite in the direction of $(\frac{2}{3}\ P\ 2)$ and $-(2\ P\ 2)$, and observed moreover in the greenish-yellow sphene from St. Gotthardt, he does not consider as essential, but dependent on the circumstances of occurrence.

Pyrochlore.—The presence of thoria, found by Wöhler(5) in pyrochlore of Miask, had been called in question by Hermann(6); hence Wöhler has induced Städeler to repeat his analysis of the ore. The earth was examined with the most rigorous accuracy, and a specimen sent to Berzelius. Both assert that it is actually thoria(7).—Hermann adheres, however, to his former assertion(8). He believes that the composition of pyrochlore may vary by the substitution of its isomorphous constituents, inasmuch as he found 5·57 per cent of zirconia, while Wöhler had observed none whatever. He states, moreover, that in a specimen of pyrochlore from Brevig, Wöhler himself found 5·15 per cent of thoria, while not a trace was met with in another specimen; it deserves to be noticed, however, that of the bases in general CaO and U_2O_3 only were determined. Hermann now considers the acid (tantalic acid) contained in pyrochlore to be ilmenic acid, mixed with some niobic, and probably also pelopic acid. (Comp. the article on Samarskite, II, 432).

Yttrotantalite.—Peretz(9) has analysed, in H. Rose's laboratory, a specimen of black yttrotantalite, from Ytterby, of a spec. grav. 5·67. His results essentially agree with those obtained by Berzelius.

TaO_3	WO_3	YO	FeO	CaO	UO	MgO	CuO	Total.
58·65	0·60	21·25	6·29	7·55	3·94	1·40	0·40	100·08

(1) Ann. Ch. Phys. [3] XX, 84.
(2) Pogg. Ann. LVIII, 277; Breithaupt's Handb. der Miner. III, 749.
(3) Ann. des Mines [4] VI, 325; Rammelsb. Handw. 2. Suppl. 158.
(4) Ann. Ch. Phys. [3] XIV, 47; Rammelsb. Handwörterb. 3. Suppl. 123.
(5) Pogg. Ann. XLVIII, 83; Berz. Jahresber. XX, 244.
(6) J. Pr. Chem. XXXI. 94; Berz. Jahresber. XXV, 375.
(7) Ann. Ch. Pharm. LXI, 264.
(8) J. Pr. Chem. XL, 475.
(9) Berl. Acad. Ber. 1847, 224; J. Pr. Chem. XLII, 143 (in abstr.); Pogg. Ann. LXXII, 155.

Yttrotantalite.

Various specimens suffered, on ignition, a loss in weight respectively of 3·9, 4·86, and 5·54 per cent, the mineral assuming at the same time a yellowish-brown colour, and acquiring a higher spec. grav. than it exhibited before ignition, namely 6·40. Rose has submitted the acid contained therein to a more minute examination. It is tantalic acid of precisely the same properties as that contained in the tantalite from Finland. The chlorides prepared from both likewise agreed with each other. Not a trace of either niobic, or pelopic acid was found.

Hermann(1) has also convinced himself that the acid contained in this mineral is actually tantalic acid, which he had doubted at an earlier period,(2) in consequence of the spec. grav. (4·05) observed being too low. Repeated experiments gave the spec. grav. = 6·7. He assumes the composition of tantalic acid to be, like that of niobic and pelopic acids, = MO_2, and represents yttrotantalite by the formula 2 (YO, UO), TaO_2.

Euxenite and Polycrase.—Scheerer(3) has obtained, under the name of yttrotantalite, a mineral which, with exception of a somewhat higher spec. grav. (from 4·73 to 4·76), so closely agrees with the euxenite from Jölster(4), that he considers the two to be identical. It occurs in the neighbourhood of Tvedestrand, imbedded in reddish-brown orthoclase. The crystals are rhombic; $P \,.\, \infty P \,.\, \infty \breve{P} \infty$. $m \bar{P} \infty$ ($m = 2$?). According to approximative measurement $\infty P = 140^0$; $P = 152^0$ (both in the brachydiagonal principal section). Analysis performed with a small quantity of material gave:

Metallic acid.	YO	UO	CeO	FeO	HO	Total.
53·64	28·97	7·58	2·91	2·60	4·04	99·74

The metallic acid was found to be a mixture of tantalic, niobic, and pelopic acids, the former prevailing. Scheerer found, likewise, pelopic and niobic acids in euxenite from Jölster; even at an earlier period he had stated that this mineral contains no tantalic acid(5). The same remarks apply to polycrase(6), which Scheerer is inclined to class with euxenite, on account of its similarity both in crystalline form and other properties; the trifling difference, according to him, being due to the different proportion of isomorphous constituents.

(1) J. Pr. Chem. XLIV, 207.
(2) J. Pr. Chem. XXXVIII, 102.
(3) Pogg. Ann. LXXII, 566.
(4) Pogg. Ann. L, 149; Berzelius' Jahresber. XXI, 179.
(5) Berzelius' Jahresber. XXVI, 374.
(6) Pogg. Ann. LXXII, 568.

Columbite (tantalite).

Columbite (Tantalite).—The following varieties of columbite have been investigated: I. Columbite from North America, by Grewinck. Spec. grav. of fragments = 5·323, of the powder = 5·320(1).—II. A Siberian specimen by Th. Bromeis(2). Spec. grav. = 5·44. Interpenetrated by samarskite; the specimen was sent by Afdeef to H. Rose, in whose laboratory both analyses were performed.—III. From Middletown in North America, by Hermann(3). Spec. grav. = 5·80. Streak dark clove-colour.—IV. From Chanteloube (Limoges), a new locality. Examination and analysis by Damour(4). Spec. grav. = 7·64 to 7·65. Amorphous, bluish-black; fracture smooth brilliant-black; streak greyish-black. Infusible. Heated with charred tartar and soda before the blow-pipe, it yields a bead of tin. Not attacked by acids.—V. Likewise from the same locality, by Damour(5). Rectangular prisms, with truncated edges and angles similar to those of columbite from Bavaria; spec. grav. = 5·60 to 5·727. Heated with phosphorus-salt in the reducing flame of the blow-pipe, it yielded a brownish-yellow bead. Decomposed by concentrated sulphuric acid.

	I.	II.	III.	IV.	V.			
					a.	b.	c.	d.
Met. acids.	80·06	78·59	78·22	—	78·44	78·88	78·90	77·92
TaO_3	—	—	—	82·98	—	—	—	—
WO_3	—	—	0·26	—	—	—	—	—
SnO_2	0·96	—	0·40	1·21	—	—	—	—
SiO_3	—	—	—	0·42	—	—	—	—
FeO	12·59	12·76	14·06	14·62	14·96	14·04	14·50	14·56
MnO	5·97	4·48	5·63	trace	6·52	7·83	7·15	8·19
YO	—		—	—	—	—	—	—
CaO	—	0·75	—	—	—	—	—	—
MgO	—	3·01	0·49	—	—	—	—	—
CuO	0·44	0·04	—	—	—	—	—	—
PbO		—	—	—	—	—	—	—
U_2O_3	—	0·56	—	—	—	—	—	—
Total	100·02	100·19	99·06	99·23	99·92	10·075	100·55	100·67

(1) Pogg. Ann. LXX, 572; Berl. Acad. Ber. 1847, 86, (in abstr.); J. Pr. Chem. XLI, 219.

(2) Pogg. Ann. LXXI, 157; Rammelsb. Handw. 3. Suppl. 118.

(3) J. Pr. Chem. XLIV, 207.

(4) Ann. des Min. [4] XIII, 337; Compt. Rend. XXV, 670, (in abstr.); J. Pr. Chem. XLII, 451.

(5) Ann. d. Min. [4] XIV, 423.

Columbite (tantalite).

No V. d. in the foregoing table was somewhat disintegrated, and exhibited a dull fracture.

Half a pound of American columbite having been sent by Silliman to H. Rose, the latter has been enabled to investigate more minutely the acid contained in this mineral. It is niobic, with a very small amount of pelopic acid. The Bavarian columbite contains about half as much more of the latter, which explains its higher spec. gravity. Nearly pure niobic acid is found in Siberian columbite, which contains besides only traces of pelopic, and a minute quantity of tungstic acid. The two latter constituents are also present in the two preceding varieties.—The results obtained by Hermann essentially differ from Rose's observations. From the low combining proportion, and the reactions of the mixture of acids contained in the American columbite, Hermann infers that this mineral contains a preponderating amount of ilmenic acid, together with pelopic and niobic acids. The same acids (pelopic acid in smaller quantity), together with tungstic acid, are stated to be contained in the Siberian mineral. Its spec. grav. = 5·43 to 5·73; colour of the powder dark-brown. A specimen of columbite, from Bodenmais (spec. grav. = 6·29; streak black), contained almost pure pelopic acid. Hermann believes, however, that his niobic acid, which is obtained in the purest state from æschynite, is somewhat different from the acid which Rose has designated by this name.—According to Hermann, the general formula of the columbites is = 2 RO, 3 (IlO_2, NbO_2, PeO_2), that of the tantalite from Finland = 2 RO, 3 TaO_2.—Damour assigns the same formula to No. IV. In consequence of the high spec. grav., he considers as very improbable the presence of NbO_2 and PeO_2, in addition to TaO_2; on the other hand, he believes them to occur in the crystallized columbite (No. V.).

Samarskite (Uranotantalite; Yttroilmenite).—Hermann, as is well known, states that he has discovered(1) the acid of a new metal, ilmenium, in the yttrotantalite from the Ilmen Mountains, which he now terms yttroilmenite. This mineral, of spec. grav. from 5·614 to 5·68, as admitted by Hermann, so closely resembles the uranotantalite of G. Rose(2), that the Siberian mineralogists regard them as one and the same mineral. Moreover, the specimens of the mineral which were sent by Hermann to G. Rose, were declared by the latter mineralogist to be identical with uranotantalite. According

(1) J. Pr. Chem. XXXVIII, 91, 119.

(2) Pogg. Ann. XLVIII, 555; G. Rose, Reise n. d. Ural II, 72.

Samarskite.

to Auerbach, it is isomorphous with columbite. In specimens of uranotantalite (obtained from Samarski and Afdeef), which, according to H. Rose, is identical with yttroilmenite, but of lower spec. grav. (from 5·39 to 5·45), the latter has found only niobic and tungstic acids. Titanic acid, of which yttroilmenite is stated to contain 5·9 per cent, was entirely absent. A new investigation of the mineral obtained from Afdeef, performed by Peretz(1), under the direction of H. Rose, gave:

	Metallic acids.	U_2O_3	FeO	YO	MgO	CaO and MgO.	Total.
1.	56·38	14·16	15·43	9·15	0·80	0·92	96·84
2.	56·00	16·70	15·90	11·04	0·75	1·02	101·41
3.	55·91	16·77	15·94	8·36	0·75	1·88	99·61

together with traces of protoxide of copper in No. 2. The mineral was decomposed by fusion with $KO, 2SO_3$; the effect is, however, produced also by digestion with concentrated hydrochloric or sulphuric acid. On closer examination of the metallic acids obtained, only niobic and tungstic acids were again found, which, together, exhibited the reactions assigned by Hermann to ilmenic acid; hence Rose altogether denies the existence of ilmenic acid, and the peculiarity of yttroilmenite. Uranotantalite he now terms samarskite, since the former name is no longer admissible, in consequence of the absence of tantalic acid. Owing to the isomorphism of samarskite and columbite, he imagines the sesquioxide of uranium of the former to replace the pelopic acid of the latter, and points out that sesquioxide of uranium may possibly have an atomic constitution similar to that of pelopic, niobic, and probably also to tantalic acid; in the same manner, Rose is inclined to admit that the yttria contained in samarskite may replace, in part, the protoxides of iron and of manganese. He is, however, of opinion that a satisfactory determination of the chemical constitution of samarskite, columbite, and tantalite, is still wanting.

In several subsequent communications, Hermann(2) continues to assert that samarskite differs from yttroilmenite, whose formula he assumes, on the ground of his former analyses, to be $[YO, FeO, UO], [HO_2, TiO_2]$; he still insists upon the peculiarity of ilmenic acid, which, according to his statement, is also to be met with in the pyrochlore and columbite from the Ilmen Mountains, and in the North

(1) Pogg. Ann. LXXI, 157; Berl. Acad. Ber. 1847, 131 (in abstr.); Rammelsb. Handw. 3. Suppl. 105, 129.

(2) J. Pr. Chem. XL, 475, 476; J. Pr. Chem. XLII, 129; J. Pr. Chem. XLIV, 216.

Samarskite.

American columbite. H. Rose, (1) on the contrary, declares that an acid, prepared by Wöhler from the pyrochlore of Miask, is likewise a mixture of niobic and tantalic acids, with a small quantity of tungstic and pelopic acids. He points out, moreover, that the difference in the spec. grav. of samarskite and of yttroilmenite, is probably due to the fact of his having employed the mineral, in its normal state, whereas Hermann operated upon the mineral after ignition. By ignition, the spec. grav. is stated to be diminished.

Tungstates. Wolfram. — Kussin (2) has analysed wolfram from Zinnwald, and Kerndt (3) (under the direction of H. Rose) has investigated the same, together with wolframs from 13 other localities, 8 of the latter not having been previously examined (No. 2. to 8. and 10). The classification of the wolframs by Breithaupt into the oligonous variety (streak reddish-brown; spec. grav. from 6·9 to 7·1), and the diatomous variety (streak blackish-brown; spec. grav. from 7·3 to 7·5) appears to be supported by these analyses, since the former pretty accurately agree with the formula 2 (FeO, WO_3) + 3 (MnO, WO_3), whilst the latter are represented by the expression 4 (FeO, WO_3) + MnO, WO_3.—Kerndt determined the tungstic acid by fusing the pulverized mineral with carbonate of soda, exhausting the fused mass, precipitating the solution with nitrate of suboxide of mercury, and igniting. The acid thus obtained, was examined in every case by means of hydrofluoric and silicic acids. In some varieties Kerndt believed that he has recognised a small amount of niobic acid.

Kussin.

Tungsten from Zinnwald.

Calculated.		Found.		
5 WO_3	76·89	75·89	75·92	75·90
2 FeO	9·30	9·43	9·38	9·40
3 MnO	13·81	13·80	14·04	13·86
	100·0	99·12	99·34	99·16

(1) Pogg. Ann. LXXII, 469; Berl. Acad. Ber. 1847, 279; J. Pr. Chem. XLII, 252; Pogg. Ann. LXXIII, 449.

(2) Rammelsberg's Handw. 3. Suppl. 127.

(3) J. Pr. Chem. XLII, 81.

Kerndt.

		Zinnwald.	Lock Fell. Cumberland.	Neu bescheert Glück. Freiberg.	Huntington. Connecticut.	Trumbul. Connecticut.	Mäuseberg, near Neudorf. Hartz.	Schlackenwalde.	Altenberg.
Spec. grav.		1.	2.	3.	4.	5.	6.	7.	8.
Grains .		7·22	7·231	7·223	7·411	7·218	7·231	7·482	7·198
Powder .		7·23	7·239	7·229	7·486	7·269	7·230	7·535	7·189
Calculated:		Found:							
5 WO_3	76·89	76·34	75·62	75·96	75·83	75 47	75·76	75·80	75·68	75·43
2 FeO	9·30	9·61	9·54	9·53	9·20	9·53	9 73	9·78	9·56	9·64
3 MnO	13·81	14·20	14·85	14·49	15·56	14·26	14·49	14·41	14·30	14·90
	100·0	100·15	100·01	99·98	100·59	99·26	99·98	99·99	99·54	99·97

Kerndt.

		Ehrenfriedersdorf.	Nertschinsk.	Montevideo.	Chanteloube.	Harzgerode.	Godolphinsball. Cumberland.
Spec. grav.		9.	10.	11.	12.	13.	14.
Grains .		7·499	7·496	7·499	7·480	7·225	7·209
Powder .		7·540	7·503	7·513	7·510	7·228	7·230
Calculated:		Found:					
5 WO_3	76·82	75·85	75·64	76·02	75·82	75·90	75·92
4 FeO	18·59	19·26	19·55	19·20	19·32	19·24	19·35
1 MnO	4·59	4·89	4·80	4·75	4·84	4·80	4·73
	100·00	100·00	99·99	99·97	99·98	99·94	100·00

Kerndt has, moreover, determined the crystalline form of wolfram. His measurements (principal axis : macrodiagonal : brachydiagonal = 0·8134 : 1 : 0·8659), closely agree with those of Phillips. He believes, with G. Rose, that this mineral belongs to the rhombic system, inasmuch as the hemihedric occurrence of the planes of the octahedron, as well as the dissimilar appearance and expansion of the front and back planes of $\frac{1}{2}\,\bar{P}\,\infty$, in consequence of which, this mineral was believed to belong to the monoclinometric system, is only met with in the wolframs of certain localities, *e. g.*, Zinnwald. In the latter variety, Kerndt observed a new twin formation similar to that of the cross-stone, and 2 parallel penetrations in the direction of 0 P and $\infty\,\bar{P}\,\infty$.

Wolfram. Rammelsberg(1) has analysed a brownish-red, acicular mineral from Schlackenwalde, surrounded by lithomarge, with disseminated fluor-spar and apatite. Spec. grav. = 6·45.

WO_3.	FeO.	MnO.	CaO.	Al_2O_3.	SiO_3.	Loss on ignition.	PO_5 and Fl.	Total.
67·05	6·72	19·73	3·02	1·01	1·08	0·78	0·61	100·0

Scheelitine.—Kerndt(2) has investigated the tungstate of lead from Zinnwald. His measurements agree within a few minutes with those of Levy. P = 131° 24′ 46″ (middle-edges); 99° 44′ 24″ (polar edges). Principal axis = 1·567. He observed P . ½ P . P ∞ . ∞ P . 0 P. Hardness = 3½ to 4. Spec. grav. in grains = 8·103, in the form of powder = 8·127; streak almost colourless, somewhat inclining to yellow. He found the composition of clove-brown crystals = (PbO, CaO, FeO, MnO), WO_3.

	WO_3.	PbO.	CaO.	FeO and MnO.	Total.
1.	51·43	47·12	1·26	0·31	100·12
2.	52·03	44·86	1·53	0·63	99·05
Calculation . .	51·58	48·42	—	—	100·00

Molybdates. Yellow Lead-Ore.—John Brown(3) has decomposed yellow lead-ore, from a locality not mentioned, by digestion with hydrosulphate of sulphide of ammonium, and determined the Pb as PbO, C_2O_3, and the Mo as MoS_3.

	Calculated.	Found.
PbO . . .	61·48	60·23
MoO_3 . . .	38·52	39·19
	100·00	99·42

Vanadates. Pyromorphite containing Vanadium.—On re-opening an abandoned mine, *mina grande*, near San Yago, in Chili, a vein of dingy-yellow, compact pyromorphite (I) has been discovered nearly 0·5 metre in thickness. In the numerous cavities of this vein, a brownish-black earthy mass is contained (II), which likewise frequently forms compact nodules of brownish-yellow streak. They fuse even in the flame of a candle to a black bead. Domeyko(4) has analysed both substances.

	PbO.	CuO.	VO_3.	AsO_5.	PO_5.	PbCl.	SiO_3 ?	CaO.	Al_2O_3 and Fe_2O_3.	Clay.	HO.	Total.
I.	58·3	0·9	1·8	11 5	5·1	9·0	—	7·9	1·1	2·0	1·1	98·7
II. a.	54·9	14·6	13·5	4·6	0·6	0·3	1·0	0·5	3·5	1·0	2·7	97·2
II. b.	51·9	16·9	13·3	4·6	0·6	0·3	1·3	0·5	3·4	1·5	2·7	97·0

(1) Rammelsberg's Handwörterb. 3. Suppl. 127.
(2) J. Pr. Chem. XLII, 81.
(3) Phil. Mag. [3] XXXI, 253; J. Pr. Chem. XLII, 432.
(4) Compt. Rend. XXIV, 793; Ann. des Mines [4] XIV, 145.

Since in II a. and b. the oxygen contained in PbO : CuO : VO_3 = 3·7 : 3·4 : 3·4, Domeyko believes that we may assume the existence of a definite compound of the formula 6 PbO, VO_3 + 6 CuO, VO_3. Volborthite.

Volborthite.—Volborthite, which has hitherto been met with exclusively in the Uralian Mountains, has been found by Credner(1) upon a vein of brown iron-ore of the Gottlob's mine, near Friedrichsrode. It occurs interpenetrated by pyrolusite, and by a new cupreous manganese-ore (crednerite); or in the form of an incrustation upon psilomelane. Credner has investigated I. foliaceous volborthite, spec. grav. = 3·495; II. a fine grained, grey variety, spec. grav. = 3·86; and III. a fine-grained, siskin-green-coloured specimen.

	CuO.	CaO.	MgO.	MnO.	VO_3.	HO.	Insoluble.	Total.
I.	44·15	12·28	0·50	0·40	36 58	4·62	0·10	98·63
Calculation	45·81	13·16	—	—	37·39	3·64	—	100·00
II.	38·27	16·65	0·92	0·52	39·02	5·05	0·76	101·19
III.	38·90	17·40	0·87	0·53	36·91	4·62	0·77	100·00
Calculation	39·29	18·82	—	—	38·18	3·71	—	100·00

Credner adduces the general formula 4 RO, VO_3 + HO, or more correctly 3 RO, VO_3 + RO, HO? In I. RO = $\frac{2}{7}$ lime, and $\frac{5}{7}$ protoxide of copper, while in II. and III. it represents $\frac{2}{5}$ of the former, and $\frac{3}{5}$ of the latter.

Arseniates. Condurrite.—This mineral, first analysed by Faraday(2), and subsequently by Kobell(3), has been again investigated by Rammelsberg(4) and by Blyth(5). Arsenious acid may be extracted from it by water, potassa, carbonate of ammonia, and by hydrochloric acid; the two latter likewise remove suboxide of copper.—According to Rammelsberg, hydrochloric acid dissolves 62·29 per cent of Cu_2O and 3·70 of AsO_3. In the unaltered and coloured residue there remain 12·81 of Cu; 13·89 of As; 2·20 of S; 0·70 of Fe_2O_3 and SiO_3. Condurrite, moreover, contains 5·83 HO. Two analyses of the entire mineral gave as the mean 70·26 of Cu; 18·27 of As; 0·66 of Fe, and 1·07 of residue.

Blyth has made not less than 13 analyses, in which the amount of arsenic varied between 17·37 and 19·88 per cent, and that of the copper between 55·47 and 60·83 per cent; he gives as the mean of the four best analyses 60·21 of Cu; 19·51 of As; 0·25 of Fe;

(1) Jahrb. Miner. 1847, 1. Hft.; Pogg. Ann. LXXIV, 546.
(2) Phil. Mag. 1827, 286.
(3) J. Pr. Chem. XXXIX, 204; Berz. Jahresber. XXVII, 258.
(4) Pogg. Ann. LXXI, 305; Rammelsberg's Handwörterb. 3. Suppl. 19.
(5) Chem. Soc. Qu. J. I, 213; Ann. Ch. Pharm. LXVI, 362.

Condurrite. 2·33 of S; besides 27·70 per cent of water, organic matter, and oxygen.—Both chemists regard condurrite, not as a definite compound, but as mixture of suboxide of copper, arsenious acid (copper pyrites, Blyth), and the residue of an arsenical copper, by whose disintegration the mineral has been formed. Rammelsberg calculates the formula of the original arsenical copper, from the portion which is insoluble in hydrochloric acid, as $Cu_2 As_3$; Blyth, however, deduces the formula $Cu_6 As$ from that of the entire mineral [the composition, according to Domeyko(1), of white copper from Calabazo, in Chili], although he himself proved that the original relation between the copper and arsenic can no longer exist in condurrite.

Phosphates. Pyromorphite (as a Furnace-Product).—From the iron-furnace at Asbach (district of Bernkastel, Mosel), where iron-ore, containing phosphoric acid and protoxide of lead, is smelted, Noeggerath(2) obtained specimens of pyromorphite in well-formed six-sided prisms, and in bud-shaped aggregates, which remain attached to the stones of the masonry.

Monazite.—In opposition to Kersten(3), Berzelius(4) and Wöhler(5), Hermann(6) has repeatedly denied the presence of thoria in monazite from Miask. He formerly imputed to Kersten the having confounded sulphate of sesquioxide of lanthanium with a salt of thorium; now he declares that it was a newly-discovered basic sulphate of protoxide of cerium. According to the experiments of Hermann, the cerium is contained in monazite, not in the form of sesquioxide, but as protoxide; hence he now corrects his earlier analysis as follows:

PO_5.	CeO.	LaO.	CaO.	MgO.	SnO_2.	Total.
28·05	37·36	27·41	1·46	0·80	1·75	96·83

The loss of 3·17 per cent, which is here evident, arises from water which was not before observed; since, by igniting the mineral in the air, it is exchanged for the oxygen required in the formation of sesquioxide of cerium. The stannic acid is contained in the form of a stannate, $3\,RO, 2\,SnO_2$, which may be removed by lixiviation. After deducting the latter, the analysis agrees with the formula proposed by Berzelius, 3 (CeO, LaO), PO_5(7).

Monazitoide.—Hermann(8) has found a new mineral, occurring together with monazite, and to which he assigns the name mona-

(1) Ann. des Mines [4] III, 9.
(2) Jahrb. Miner. 1847, 1. Hft.
(3) Pogg. Ann. XLVII, 395.
(4) Berzelius' Jahresber. XXV, 377.
(5) Pogg. Ann. XLVII, 424.
(6) J. Pr. Chem. XL, 21.
(7) Berzelius' Jahresber. XX, 245.
(8) J. Pr. Chem. XL, 28.

Monazitoide.

zitoide. It is very similar to the former, and possesses exactly the same crystalline form. Colour brown; lustre resinous; translucent. Hardness = 5. Spec. grav. = 5·281. Highly luminous, but infusible, before the blow-pipe; only partially decomposed by hydrochloric acid, with evolution of chlorine. Composition:

PO_5.	TaO_3?	CeO.	LaO.	CaO.	HO.	Total.
17·94	6·27	49·35	21·30	1·50	1·36	97·92

besides traces of MgO and Fe_2O_3. The acid which is analogous to tantalic acid resembles that contained in the tantalite from Finland. Hermann believes it to occur as 2 RO, TaO_2, which he deducts, as he did stannic acid in monazite, and adduces for monazitoide the formula 5 (CeO, LaO), PO_5.—Monazite and monazitoide, according to Hermann, form heteromeric mixtures which have a spec. grav. of from 5·12 to 5·25. A crystal thus constituted, and of spec. grav. 5·18 gave 22·70 PO_5; 3·75 TaO_3; 73·55 RO, and, therefore, contained nearly equal parts of both minerals.

Aluaudite.—Damour(1) has described a new mineral, which is allied to triphylline, and was discovered by Mathieu in the graphic granite near Chanteloube (Limoges). It occurs in large foliaceous masses of a clove-brown colour, exhibiting a perfect cleavage in two directions, and an imperfect cleavage in the third. The planes of cleavage are at right angles to each other. In thin splinters, translucent. It scratches fluorspar, but is itself scratched by steel. Spec. grav. =3·468. Heated in a flask it decrepitates, and readily fuses before the blow-pipe, with intumescence, to a non-magnetic bead. It readily dissolves in hydrochloric acid with evolution of a trifling amount of chlorine.

	PO_5.	Fe_2O_3.	MnO.	MnO_2.	NaO.	HO.	SiO_3.	Total.
Found . . .	41·25	25·62	23·08	1·06	5·47	2·65	0 60	99·73
Calculated .	42·63	23·38	26·63	—	4·67	2·69	—	100·00

Formula = 3 ($\frac{5}{6}$ MnO, $\frac{1}{6}$ NaO), $PO_5 + Fe_2O_3$, $PO_5 + HO$.

Vivianite.—Respecting the formation of this mineral, comp. I, 339.

Gibbsite.—Hermann(2), by his investigation of hydrargillite (comp. II. p. 393), was likewise induced to analyse gibbsite. He found that Torrey and Thompson have overlooked the phosphoric acid which is present to the amount of 36·87 per cent, as at a former

(1) Compt. Rend. XXV, 670; Ann. des Mines [4] XIII, 341; J. Pharm. [3] XIII, 160 (in abstr.); J Pr. Chem. XLII, 453.

(2) J. Pr. Chem. XL, 32.

Gibbsite.

period, Davy, Klaproth, Gregor, and John had missed this acid in wavellite. The composition is $= Al_2 O_3, PO_5 + 8 HO$, which, as Rammelsberg(1) remarks, is the composition of artificial phosphate of alumina, prepared by precipitating alum with phosphate of soda.

		$Al_2 O_3$.	PO_5.	HO.	Residue.	Total.
Found . . .	I.	26·13	36·87	35·00	2·00	100·00
	II.	26·66	37·62	35·72	—	100·00
Calculated . . .		26·38	36·65	36·97	—	100·00

Hermann does not state that he has examined for fluorine.

Lazulite.—By numerous measurements of lazulite from Wehrau, with the reflective-goniometer, Prüfer(2) has pointed out that this mineral belongs to the monoclinometric and not to the rhombic system of crystallization. His statements are: $a = 88^0\ 2'$; principal axis: orthodiagonal: clinodiagonal: $= 1{\cdot}708 : 1 : 0{\cdot}975$; $P = 99^0\ 40'$ and $100^0\ 20'$ in the clinodiagonal principal section, $97^0\ 30'$ in the orthodiagonal principal section, $135^0\ 25'$ in the base; $P\infty = 120^0\ 20'$; $(P\infty) = 61^0\ 25'$; $\infty P = 91^0\ 30'$; $P\infty : 0P = 118^0\ 30'$.—The crystals, possessing numerous planes, are either prismatic by the predominance of $+P$, or tabular from the prevalence of $-P\infty$. They exhibit, moreover, for the most part a twin formation, in the direction of $\infty P\infty$, and present a rhombic pyramidal appearance. In other cases a twin formation is perceptible in the direction of $-\frac{2}{3}P$. Haidinger states that lazulite exhibits the phenomenon of dichroism(3).

Phosphorochalcite and Ehlite.—Rhodius(4) has analysed, under the direction of Will, I. phosphorochalcite from Rheinbreitbach; and II. ehlite from Ehl, near Linz. (The former occurs in reniform aggregates, with projecting extremities of well-formed crystals. In thin splinters transparent, and emerald-green. The latter is very similar to the preceding mineral, only somewhat brownish, and on application of heat it suddenly splits into delicate fibres. Ettling). Both minerals were extremely pure, and especially free from arsenic acid.

		CuO.	PO_5.	HO.	Total.
	I.	70·8	20·4	8·4	99·6
Calculation . . .		70·64	21·36	8·00	100·0
	II.	63·1	28·9	7·3	99·3
Calculation . . .		63·83	28·94	7·23	100·0

(1) Rammelsb. Handw. 3. Suppl. 48.
(2) Haidinger's Abhandl. (comp. II, 379) I, 169; Haiding. Berichte II, 226.
(3) Haiding. Abhandl. I, 175.
(4) Ann. Ch. Pharm. LXII, 369.

Phosphorochalcite is accordingly 3 CuO, PO_5 + 3 (CuO, HO), as Kühn had previously found; the formula of ehlite, however, is 3 CuO, PO_5 + CuO, 2 HO.—Since his analysis of ehlite agrees with that of libethenite by Berthier(1), Rhodius is inclined to regard both as identical; but whoever has seen these minerals will agree with Hausmann(2), that they differ in their appearance too considerably to admit of their being united under one head. Kühn's(3) cupreous diaspore, of which one is reminded by the deportment of ehlite under the influence of heat, contains 69·61 per cent of protoxide of copper. Phosphorochalcite and ehlite.

Uranite.—Werther(4) has analysed uranite from Autun I., and chalcolite from Gunnislakė II.

	PO_5.	U_2O_3.	CaO.	BaO.	CuO.	SiO_3.	Earthy matter.	HO.	Total.
I.	14·00	63·28	5·86	1·03	—	—	—	14·30	98·47
II. a.	15·01	58·45	—	—	—	—	—	15·22	—
b.	13·52	57·20	—	—	—	—	0·61	15·55	—
c.	14·40	60·80	—	—	8·27	0·49	0·22	—	—

The analyses agree with the formula adduced by Berzelius; Werther, however, proposes the simpler (?) expression [(CuO, CaO) + 2 U_2 O_3], PO_5 + 8 HO, because he had found that in a recently discovered crystalline compound (2 U_2 O_3, HO), PO_5 + 8 HO (comp. I. 320), the basic water may be replaced by protoxide of copper on boiling with basic acetate of copper, artificial chalcolite being thus produced. (Comp. also I. 321). It may be mentioned here that Genth(5) has found uranite on fossil-wood in the Seven Mountains.

Struvite.—By repeated investigation of struvite, Ulex(6) found that this mineral contains a portion of protoxide of iron and of manganese. His new analyses lead, however, to the recognized formula NH_4O + 2 (MgO, FeO, MnO) + PO_5 + 12 HO.

	NH_3 and HO.	MgO.	FeO.	MnO.	PO_5.	Total.
I.	53·62	15·50	1·11		28·90	99·13
II.	53·64	13·15	2·22	2·01	28·05	99·07
III.	53·76	13·46	3·06	1·12	28·56	99·96
IV.	54·62	11·72	4·15	1·94	27·24	99·67

(1) Ann. des Mines VIII, 334.
(2) Hausmann's Handb. d. Min. 2. Aufl. II, 1100.
(3) Ann. Ch. Pharm. LI, 125.
(4) J. Pr. Chem. XLIII, 332.
(5) Ann. Ch. Pharm. LXVI, 280.
(6) Ann. Ch. Pharm. LXVI, 41.

Sulphates. Celestine.

The ammonia and water were not separately determined.—With regard to the axes of struvite, comp. I, 20.

Sulphates. Celestine.—The well-known fibrous celestine from Dornburg, near Jena, contains, according to an analysis made in Rammelsberg's laboratory by Maddrell(1), 54·731 per cent of SrO, 1·416 of CaO and 43·756 of SO_3.

Heavy-Spar.—Fresenius(2) has analysed granular heavy-spar from Naurod, near Wiesbaden.

BaO, SO_3.	SrO, SO_3.	Fe_2O_3.	SiO_3.	HO.	Total.
89·47	1·85	0·29	8·15	0·08	99·84

Epsomite.—Upon an old bricked-up shaft of the mine at Rudain, near Königsberg, in Hungary, Jurasky(3) found the rock, containing a large amount of felspar and iron pyrites, incrusted two fingers in thickness with epsomite and sulphate of protoxide of iron. In the drusic cavities were found small six-sided crystals which, according to Haidinger's investigation, consisted of optically biaxial and monoclinometric tables: $(\infty P \infty) . \infty P \infty . 0 P . \pm P \infty$, with 2 angles of about 92°, the others being about 134°. Analysis yielded:

Al_2O_3.	FeO.	SO_3.	HO.	Insoluble matter.	Total.
14·30	2·15	36·75	44·60	2·01	99·81

which, after deducting the iron as sulphate of the protoxide, leads to the recognized formula Al_2O_3, $3 SO_3 + 18 HO$.

Lœwëite.—Haidinger(4) has described and named a new mineral discovered by Schwind at Ischl. It occurs in crystalline masses of an inch in size, and associated with large foliated anhydrite. It is indistinctly cleavable in the direction of a tetragonal pyramid with lateral edges of about 105° 2′, and terminal edges of about 111° 44′, whence the principal axis = 1·3. It is more perfectly cleavable in the direction of ∞P and $\infty P \infty$, and very distinctly in the direction of 0 P. Optically uniaxial. Doubly refringent: O = 1·491, E = 1·494. O-axis attractive. Lustre vitreous; colour sometimes yellowish-white, sometimes honey-yellow. Hardness = 2·5 to 3; brittle. Spec. grav. = 2·376. Taste feebly saline and astringent. Composition according to Karafiat:

NaO.	MgO.	SO_3.	HO.	Fe_2O_3 and Mn_2O_3.	MnO.	Total.
18·97	12·78	52·35	14·45	0·66	trace	99·21

(1) Rammelsb. Handw. 3. Suppl. 36.

(2) Ann. Ch. Pharm. LXIII, 390.

(3) Oestr. Blätter für Lit. 1847, 434; Haid. Ber. (comp. II, 379) II, 332; Jahrb. Miner. 1847, 848.

(4) Abhandl. der K. Böhm. Ges. d. W. [5] IV; Haid. Ber. II, 266.

Lœwëite.

A somewhat smaller amount of magnesia and soda was found, than that required for saturating the sulphuric acid. Starting upon the quantity of the latter we obtain 39·38 MgO, SO_3, 46·45 NaO, SO_3 and 14·45 HO, agreeing with the formula 2 MgO, SO_3 + 2 NaO, SO_3 + 5 HO. It is, however, more probable that this mineral is a compound of 1 equiv. of the double salt with 2 HO, and that the excess is hygroscopic. John's blœdite(1) may possibly be identical with lœwëite.

Medjidite.—Lawrence Smith(2) has found two new uranium-minerals upon the pitch-blende from Adrianople, one of which he named in honour of the Sultan Medjid, and the other after Liebig (comp. II, 449). Medjidite is imperfectly crystalline, transparent, and of a dark amber-yellow colour. Its planes of fracture exhibit a resinous lustre. Hardness = 2·5. Spec. grav. not stated. Heated in a flask it yields water, assumes a dark-yellow colour, and becomes black when ignited. When heated with fluxes before the blow-pipe it exhibits the reactions of uranium. It dissolves in dilute hydrochloric acid, but is insoluble in water. Composition : $U_2 O_3$, SO_3 + CaO, SO_3 + 15 HO. The details of the analysis are not given.

Sulphate of Protoxide of Copper with Protochloride of Copper.—Arthur Connel(3) has investigated a crystallized mineral from Cornwall, occurring in fine needles which, according to Brooke, belong to the hexagonal system. It is translucent, of a vitreous lustre, and of a dark-blue colour; when in fine fibres the colour is light-blue; insoluble in boiling water, but readily soluble in nitric or hydrochloric acid. Qualitative analysis pointed out the presence of CuO, SO_3 and Cu Cl, besides a little water; for quantitative examination a sufficient quantity of the mineral could not be obtained. At present only 10 specimens of this mineral are known, one of which is preserved in the British Museum.

Anhydrous Carbonates. Formation of Stalactites.—In the stalactites of the so-called Galmeihöhle (Calamine cavern), and of the Frauenhöhle (Ladies cavern), near Neuberg, in Styria, Haidinger(4) has observed that the lime is, in the first instance, deposited from the water in the form of a gelatinous substance resembling mountain-

(1) Rammelsberg's Handwörterbuch, 3. Suppl. 27.

(2) Ann. Ch. Pharm. LXVI, 253.

(3) Report of the British Association for 1847, 49; Edinb. New Phil. Journ. XLIII, 244; J. Pr. Chem. XLII, 453.

(4) Wien. Acad. Ber. II, 202; Haiding. Berichte (comp. II, 379) IV, 358.

Calcareous spar.

meal, which, by the interposition of the water impregnated with carbonic acid, becomes slowly fibrous, then of a columnar structure, and finally assumes the characteristic properties of calcareous spar, admitting of perfect rhombohedric cleavage.

Calcareous Spar.—Descloizeaux(1), during his residence in Iceland, has prosecuted some inquiries respecting the occurrence of double-spar. It is found of the known purity only at a single spot, mentioned by Robert, namely, in a narrow ravine at the entrance of the little Bay of Eskifiordur, the most northerly of the two arms in which the Bay of Rödefiordur terminates. The calcareous spar is seen only on one side of the ravine, where it occupies a space of 17·8 metres in length, and 4·2 metres in height, filling large vesicular cavities of a black rock resembling basalt. In one of these cavities occurs a mass of about 6 metres in breadth, and 3 metres in height, exhibiting in its outlines a single rhombohedron R.

Schnabel(2) has analysed double-spar from Brilon (I); Hochstetter(3), white crystallized calcareous spar of spec. grav. 2·702 (II); Richter(4), calcareous spar obtained from black lime-stone superimposed upon gypsum, from Altenmarkt (III); this specimen contained hydrosulphuric acid which imparted a black colour to lead-paper. Gibbs(5) has analysed calcareous spar containing zinc, from the calamine-mines of Olkucz (IV); and Monheim(6), the same mineral from the calamine druses at the Altenberg, near Aix-la-Chapelle (V and VI):

	CaO.	MgO.	FeO.	ZnO.	SiO_3.	CO_2.	HO.	Total.
I.	55·30	0·13	—	—	—	43·52	1·07	100·02
II.	56·00	trace	1·60	—	1·90	43·45	—	102·95
III.	56·10	—	—	—	—	43·80	0·10	100·00
IV.	50·76	0·85	0·51	4·07	—	43·81	—	100·00

	CaO, CO_2.	FeO, CO_2.	ZnO, CO_2.	MnO, CO_2.	SiO_3.	Total.
V.	89·27	9·31	1·64	—	—	100·22
VI.	89·56	3·23	1·01	0·69	0·18	99·67

Sandstone from Fontainebleau.—The well-known rhombohedrons of calcareous spar from Fontainebleau contain, according to an analysis

(1) Bulletin Géologique [2] IV, 768; Jahrb. Miner. 1848, 590 (in abstr.)
(2) Beilage zum Osterprogramm 1847 der Realschule zu Siegen, 11.
(3) J. Pr. Chem. XLIII, 316.
(4) Haidinger's Berichte (comp. II, 379) II, 479.
(5) Rammelsb. Handwörterb. 3. Suppl. 62.
(6) Rammelsb. Handw. 3. Suppl. 62.

of Morlot(1), 58, and even as much as 95 per cent of mechanically mixed sand. The trifling residue of calcareous spar was endowed with so much power of crystallization as to form with the preponderating mass of sand rhombohedrons 2 inches in size, retaining the property of cleavage. A similar phenomena is observed in the sandstone of Walsee and Berg, the grains of which, $\frac{1}{10}$th of an inch in size, are cemented together by cleavable lime.

Sandstone from Fontainebleau.

Ankerite.—Siemianowsky(2) has analysed ankerite from the Rathhausberg, in Salzburg. Composition :

CaO, CO_2.	MnO, CO_2.	FeO, CO_2.	Total.
85·83	13·36	1·10	100·29

Bitter-spar.—Ott(3) has analysed a specimen of bitter-spar (I) from Kapnik, crystallized in the form of R.4R, in which R= 106° 16′, 4 R = 66° 5′; hardness = 3·5, spec. grav. = 2·89. Gibbs(4) has examined coarse-grained, crimson-red bitter-spar, cleavable into rhombohedrons, from Prizbram (II). It is distinguished by containing CoO, CO_2, which has hitherto been met with only in the calcareous sinter from Riechelsdorf. Gerned(5) has analysed the "rauhkalk" from Beyenrode, in the Thüringerwald (II).

	CaO.	MgO.	FeO.	MnO.	CoO.	CO_2.	Total.
I.	29·43	19·60	0·68	3·60	—	46·50	99·81
II. a.	31·72	16·63	1·36	—	5·17	45·12	100·00
b.	31·86	17·37	1·16	—	4·24	45·37	100·00
III.	28·93	23·46	3·48	—	—	42·45	98·31

All approximately lead to the formula $CaO, CO_2 + RO, CO_2$.

Magnesite.—Brunner(6) found a specimen of magnesite from Greece to be composed of:

MgO.	CO_2.	Al_2O_3 and Fe_2O_3.	Total.
51·026	49·492	Traces.	100·518

(1) Haiding. Berichte (comp. II, 379) II, 107.
(2) Haiding. Berichte I, 193; respecting the structure of ankerite, comp. Leydolt ibid. I, 115.
(3) Haiding. Berichte, II, 403.
(4) Pogg. Ann. LXXI, 564; J. Pr. Chem. XLII, 458.
(5) Rammelsb. Handw. 3. Suppl. 26.
(6) Verhandl. der Schweiz. Naturf. Gesellschaft in Winterthur, 1847; Jahrb. Miner. 1848, 482.

Mesitine-spar Pistomesite).

Mesitine-spar (Pistomesite).—At the suggestion of Breithaupt, Fritzsche(1) has analysed the crystallized mesitine-spar from Traversella in Piedmont (I); the same mineral (II) has likewise been analysed by Gibbs(2). Both found it to contain 2 (MgO, CO_2) + FeO, CO_2, while, according to a letter communicated to Breithaupt(3), Stromeyer had obtained equal equivalents of the two constituents.—Fritzsche(4), however, arrived at the latter composition when analysing a specimen of mesitine-spar from Thurnberg, near Flachau, in Salzburg (IV), which occurs in rhombohedrons of 107^0 18′, and of a spec. grav. from 3·412 to 3·417; hence Breithaupt separates this variety of mesitine-spar from the others, as a distinct species, and assigns to it the term pistomesite.—The mean of the two foregoing ratios 5 (MgO, CaO, CO_2) + 3 (FeO, CO_2), according to Patera(5), represents the mesitine-spar which accompanies the lazulite of Werfen(V). It is cleavable in the direction of R 107^0 10′), of a light-brown colour, and of 3·33 spec. grav.

	I.	II.	III.	IV.	V.
FeO	24·18	26·61	35·13	33·92	27·37
MgO	28·12	27·12	20·66	21·72	26·76
CaO	1·30	0·22	—	—	—
CO_2	45·76	46·05	44·21	43·62	45·84
	99·36	100·00	100·00	99·26	99·97

Earthy Carbonate of Manganese.—Kane(6) has found a stratum of earthy carbonate of protoxide of manganese several inches in thickness under a bed of turf which rests upon old red sandstone near Glandree, parish of Tulla, in the county of Clare, in Ireland. In colour the purest specimens equal that which is artificially prepared; for the most part, however, it is yellowish-brown, from the turf with which it is mixed. Analysis yielded:

	MnO, CO_2.	CaO, CO_2.	FeO, CO_2.	Clay and sand.	Organic Mat. Water and loss.	Total.
1	74·55	trace	15·01	0·33	10·11	100·00
2	79·94	2·43	11·04	0·37	6·22	100·00

(1) Pogg. Ann. LXX, 146.
(2) Pogg. Ann. LXXI, 566.
(3) and (4) Pogg. Ann. LXX, 146.
(5) Oestr. Blätter f. Literatur, 1847, 363; Haiding. Berichte (comp. II, 379) II, 296; Haiding. Abhandl. I, 175; Jahrb. Miner. 1848, 65.
(6) Phil. Mag. [3] XXXII, 37.

Siderose. — Rosengarten(1) has investigated a specimen of brownish-black, crystallized iron-spar (I), partly converted into brown iron-ore, from the Wölch, in the Lavant-valley, in Carinthia. Glasson(2) has analysed almost perfectly white crystals from Bieber, in the Electorate of Hesse (II); Schnabel(3) sphærosiderite from the basalt of the Alte Birke mine, near Eisern, in the vicinity of Siegen (III); Monheim(4), some green crystals found upon the brown iron-ore from the Altenberg, near Aix-la-Chapelle (IV), having a spec. grav. =3·60, and containing a large amount of lime. Siderose.

	FeO.	Fe_2O_3.	MnO.	CaO.	MgO.	CO_2.	Insol.	Total.
I.	43·83	11·30	7·31	—	2·44	35·12	—	100·0
II.	53·06	—	4·19	1·08	2·23	38·37	0·48	99·41
III.	43·59	—	17·87	0·08	0·24	38·22	—	100·0

	8 (FeO, CO_2.)	2 (MnO, CO_2)	3 (CaO, CO_2)	SiO_3.	Total.	
IV.	64·04	16·56	20·22	1·10	101·92	found.
	63·58	15·81	20·61	—	100·00	calculated.

Ferruginous Zinc-spar (Capnite).—Monheim(5) has analysed the ferruginous zinc-spar from Altenberg, near Aix-la-Chapelle, which is represented by Breithaupt as a distinct species, "*capnite*:"

	Spec. grav.	ZnO, CO_2.	FeO, CO_2.	MnO, CO_2.	CaO, CO_2.	MgO, CO_2.	Cala-mine.	Total.
1	4·09	71·08	23·98	2·58	2·54	—	—	100·18
2	4·15	60·35	32·21	4·02	1·90	0·14	2·49	101·11
3	4·00	58·52	35·41	3·24	3·67	—	0·48	101·32
4	4·04	55·89	36·46	3·47	2·27	—	0·41	98·50
5	4·00	40·43	53·24	2·18	5·09	—	—	100·94
6	—	28·00	67·00	—	5·00	—	—	100·00

Since the amount of iron, as was to be expected, proved to be exceedingly variable, Monheim considers the assumption of a distinct species to be inadmissible, and proposes the term zincous iron-spar for the light-green varieties which are rich in zinc, and the name ferruginous zinc-spar for the dark-green, or those varieties which have become brown by oxidation of the iron.

(1) Rammelsb. Handw. 3. Suppl. 112.
(2) Ann. Ch. Pharm. LXII, 91; comp. I, 338.
(3) Osterprogramm der Realschule zu Siegen 1847, 7.
(4) Verh. des Naturhist. Vereins der Preuss. Rheinl. 1848, 36; Jahrb. Miner. 1848, 585.
(5) Verh. des Naturhist. Vereins der Preuss. Rheinl. 1848, 36; Rammelsb. Handw. 3. Suppl. 131.

Manganous zinc-spar.

Manganous Zinc-spar.—Monheim has also investigated zinc-spar from Aix-la-Chapelle, which is distinguished by the large amount of manganese it contains. I. Light-green rhombohedrons of a spec. grav. = 4·03. II. A dark-green specimen, of a spec. grav. = 3·98; both(1) from the Herrenberg. III. A yellowish-white variety, from the Altenberg(2), of spec. grav. = 4·20.

	ZnO,CO_2.	MnO,CO_2.	FeO,CO_2.	MgO,CO_2	CaO,CO_2.	SiO_3.	HO	Calamine.	Total.
I.	85·78	7·62	2·24	4·44	0·98	0·09	trace	—	101·15
II.	74·42	14·98	3·20	3·88	1·68	0·20	0·56	—	98·92
III.	84·92	6·80	1·58	2·84	1·58	—	—	1·85	99 57

Hydrated Carbonates. Emerald-nickel.—Silliman, Jun.(3) has described under the name of emerald-nickel a mineral(4) from Texas, in the county of Lancaster, Pennsylvania, where it occurs as a stalactitic incrustation upon chrome-iron; it appears to have been known to the American mineralogists, since 1846, under the name of green sesquioxide of chromium. This mineral is amorphous, having an uneven and somewhat scaly fracture. Hardness = 3 to 3·5; spec. grav. = 2·57 to 2·693; highly lustrous; colour emerald-green, streak yellowish-green. Heated in a flask it yields water, and assumes a blackish-grey colour. Hydrochloric acid readily dissolves it, with effervescence, a portion of chrome-iron remaining behind. In a former analysis, Silliman overlooked the carbonic acid it contains, and regarded the mineral as NiO, 2HO(5). He now gives the composition $NiO,\ CO_2 + 2(NiO,\ 3HO)$.

	NiO.	CO_2.	HO.	Total.
Found . .	58·82	11·69	29·49	100·00
Calculated .	59·73	11·66	28·61	100·00

Hydro-nickelmagnesite.—Shepard(6) assigns the name of hydro-nickelmagnesite to a correlative mineral which occurs at the same locality upon serpentine, containing magnesia in addition to the

(1) Verhandl. des Naturhist. Vereins der Preuss. Rheinl. 1848, 171.
(2) Rammelsb. Handw. 3. Suppl., 131.
(3) Sill. Am. J. [2] VI, 248.
(4) Proceed. of the Boston Nat. Hist. Soc. 1846, No. 18.
(5) Sill. Am. J. [2] III, 407; Jahrb. Miner. 1848, 587; Pogg. Ann. LXXIII, 154.
(6) Sill. Am. J. [2] VI, 250.

above-mentioned constituents. It has only been qualitatively investigated. Liebigite.

Liebigite.—Lawrence Smith(1) has discovered a new mineral upon the pitch-blende from Adrianople, and has named it in honour of Liebig. It occurs in warty, transparent masses, perfectly cleavable in one direction, and of a beautiful apple-green colour. Hardness = 2 to 2·5; spec. grav. not stated. Heated in a flask, it loses water and assumes a grey colour; exposed to a red-heat, it becomes black, and orange-red on cooling; when more strongly heated it remains black. It gives with fluxes the reactions of uranium, and dissolves in hydrochloric acid with effervescence. The composition, according to the mean of two analyses made with a very small quantity of mineral, = U_2O_3, $CO_2 + CaO$, $CO_2 + 20$ HO.

	U_2O_3	CaO.	CO_2.	HO.	Total.
Found . .	38·0	8·0	10·2	45·2	101·4
Calculated .	36·3	7·1	11·1	45·5	100·0

Aurichalcite.—A. Connel(2) has investigated a foliaceous, pale-green, nacreous mineral, from Matlock.

ZnO.	CuO	CaO	MgO	CO_2	HO	Total.
42·5	32·5	traces		27·5		102 7

According to its composition, this mineral is allied to aurichalcite or to buratite. Since Connel did not separately determine the carbonic acid, the adduced formula 2 (ZnO, CuO), $CO_2 + HO$ appears somewhat questionable.

Borates. Boracite.—On cleaning out a bore-hole at Stassfurth, a comparatively large quantity of a mineral resembling limestone has been brought up from a depth of 1400 feet, which Karsten on closer examination has recognized as compact boracite(3). The surface of the fragments appeared corroded, and sometimes exhibited small crystals of rock-salt; fracture compact and uneven; colour snow-white, becoming yellowish on exposure to the atmosphere. Hardness = 4·5; spec. grav. = 2·9134. Under the microscope it appears amorphous, the powder, however, when heated on a metallic plate becomes pyroelectric, precisely as that of crystallized boracite(4).

(1) Ann. Ch. Pharm. LXVI, 253.
(2) Edinb. N. Phil. Journ. XLV, 36; J. Pr. Chem. XLV, 454.
(3) Karsten's Arch. XXI, 2. 491; Berl. Acad. Ber., Jan. 1847, 14; Pogg. Ann. LXX, 557; J. Pr. Chem. XL, 314.
(4) Report of the Brit. Assoc. 1847, Notices, 55

Borates. Boracite.

Analysis gave 29·48 per cent of MgO, 69·49 of BO_3, and 1·03 of FeO, CO_2, besides traces of MnO and Fe_2O_3, HO. Karsten believes that boracite forms an essential part in the composition of the rock-salt mountain of Stassfurth, and justly alludes to the high interest which the occurrence of boracite as a rock affords in reference to the exhalations of boracic acid in Italy and other places(1).

Hankel(2) has performed a series of experiments by which he has proved that the alternation of the electricities at each of the electrical poles of boracite as well as of titanite certainly takes place on application of heat, and may even be frequently repeated both by raising and diminishing the temperature. This observation, made at an earlier period by Hankel, had been contradicted by P. Riess and by G. Rose(3).

Fluorides. Chiolite.—Since the analyses of chiolite made by Hermann(4) and by Chodnew(5) did not yield concordant results, Rammelsberg(6) has analysed a specimen obtained from G. Rose, of spec. grav. varying from 3·003 to 3·077; another specimen obtained from Crantz, of a spec. grav. between 2·84 and 2·89 has been investigated by Pearce, under the direction of Rammelsberg. It appears that, under the name of chiolite, two minerals have been procured from Miask, perfectly similar in external appearance, but of different composition. The analysis by Rammelsberg agrees with that of Chodnew, when the percentage of the latter is calculated after deducting 0·59 K, 0·93 Mg, 1·04 Y (?) and the 0·86 lost by ignition, and leads to the formula $2\,Na\,Fl + Al_2\,Fl_3$. Pearce's analysis agrees with that of Hermann, and leads to the formula $3\,Na\,Fl + 2\,Al_2\,Fl_3$. The results obtained by Rammelsberg and Pearce are, in each instance, the average numbers of three analyses.

	Rammelsb.	Chodnew.	Calculation.		Hermann.	Pearce.	Calculation.
2 Na	27·68	27·48	27·40	3 Na	23·78	23·95	23·47
2 Al	15·75	17·01	16·32	4 Al	18·69	18·44	18·65
5 Fl	—	55·51	56·28	9 Fl	57·53	—	57·88
Total.		100·00	100·00		100·00		100·00

(1) Pogg. Ann. LXXI, 243; comp. Bischof, Chem. and Phys. Geologie, I, Kap. 6.
(2) Pogg. Ann. LXXIV, 231.
(3) Pogg. Ann. LIX, 351.
(4) J. Pr. Chem. XXXVII, 188; Berzel. Jahresber. XXVII, 230.
(5) Verhandl. der K. Russ. Mineral. Gesells. zu Petersb. 1845—1846, 208; Rammelsberg's Handw. 3. Suppl. 31.
(6) Pogg. Ann. LXXIV, 314; J. Pr. Chem. XLV, 455 (in abstr.)

Fluorides. Chiolite.

Accordingly we have now three distinct compounds of fluoride of sodium with fluoride of aluminum.

1. Cryolite.	2. Chodnew's chiolite.	3. Hermann's chiolite.
$3\,NaFl + Al_2Fl_3$.	$2\,NaFl + Al_2Fl_3$.	$3\,NaFl + 2\,Al_2Fl_3$.

of which the middle one might perhaps be termed nipholite ($\nu\iota\phi\omega$).

Chlorides. Rock-Salt.—Fehling(1) has investigated rock-salt from Wilhelmsglück, near Schwäbisch Hall.

	NaCl.	NaO, SO_3.	CaO, SO_3.	Ca Cl.	CaO, CO_2.	MgO, CO_2.	Clay and Fe_2O_3.	Total.
I.	99·97	—	0·02	—	—	—	0·01	100·00
II.	98·36	0·03	0·55	—	0·52	0·13	0·53	100·12
III.	98·81	—	0·11	0·02	0·16	0·15	0·80	100·05

Martinsite.—A specimen of rock-salt found at Stassfurth yielded, according to 3 concordant analyses, 90·98 per cent of Na Cl and 9·02 of MgO, SO_3, agreeing with the formula $10\,NaCl + MgO, SO_3$. Karsten(2) names it martinsite.

Mendipite.—This mineral has for some years been found in the Cunigund mine, near Brilon, in Westphalia. Rhodius(3) and Schnabel(4) have arrived at the composition previously established by Berzelius:

	Pb Cl.	2 PbO.	Total.
Rhodius . .	39·07	60·10	99·17
Schnabel . .	38·74	61·26	100·00

Mineral Tar.—According to Nendtvich(5), the mineral tar from Muraköz, in the neighbourhood of Csáktornya, in Hungary, contains no oxygen either in its solid or oily modification; it possesses, however, the same composition as Boussingault's petrolene ($C_5\,H_8$); accordingly it contains no asphaltene.

Pseudomorphs.—Several contributions have appeared respecting pseudomorphs and their formation. The limits of our Report, however, will not allow us to communicate abstracts that would possess the slightest claim to completeness; we therefore confine ourselves to merely mentioning the titles of the papers and works in

(1) Fehling, Chem. Unters. der Soolen der Würtemb. Salinen, Stuttg. 1847; Würtemb. Naturwissenschaftl. Jahreshefte, IV, 36; J. Pr. Chem. XLV, 276.

(2) Berl. Acad. Ber. 1847, 16.

(3) Ann. Ch. Pharm. LXII, 373.

(4) Osterprogramm der Realschule zu Siegen, Beilage, 1847, 10; Rammelsb. Handw. 3. Suppl. 78.

(5) Haidinger's Berichte (comp. II, 379) III, 271.

Pseudomorphs. question: 1. Pseudomorphs of sesquioxide of iron, by Haidinger, in his Abhandlungen II, 267, and also in his Berichten IV, 1.—2. Description of a, partly new, series of pseudomorphs, by Sillem, in Pogg. Ann. LXX, 565.—3. Nachtrag zu den Pseudomorphosen des Mineralreichs, by Blum, Stuttgart, 1847.—4. Lehrbuch der Phys. Geologie, by Bischof, II. Bandes 1 and 2 Abtheilung. Bonn; (these parts, like the whole work, are of the highest value as a history of the formation both of simple and compound minerals).—5. Die Lehre von der Verwitterung im Mineralreich, by Suckow, Leipsic, 1848.

CHEMICAL GEOLOGY.

Generalities. Method of chemico-geological inquiry.

Generalities. Method of Chemico-Geological Inquiry.—The most important production of the years 1847 and 1848 in this department of science is G. Bischof's Handbook of Chemical and Physical Geology(1). This is indeed the first, and up to the present time, the only work of this description in the whole range of literature, which has selected for its subject the chemico-physical processes taking place in the crust of the earth, in the formation of rocks and of springs, in the pseudomorphoses of minerals and metamorphoses of rocky strata, in the origin of metalliferous veins, beds of ore, and collateral matters. The author of this work has not only submitted to a careful scientific critique all the former observations made in this department; but has also, by very many original experiments, paved the way towards a rational exposition—so often attempted of late—of the development and transformation of the crust of the earth, and of its stratified and massive rocks. Bischof commences with an attentive consideration of well- and river-waters, and their chemical components, which must evidently be the products or educts of processes in the moist way; he endeavours to refer all these substances to the rocks from which they are derived, and to point out such reactions as may have rendered them soluble, and capable of passing into new states of combination. His explanations throughout are founded upon processes still operating within the sphere of our observation, which he considers as adequately accounting for the changes exhibited in all rocks. Bischof, by tracing each constituent of a rock to its source, is thus enabled to elaborate the conditions—frequently so complicated—under which the rock itself originated; in his discussions particular attention is devoted to

(1) Lehrbuch der chemischen und physikalischen Geologie, von Dr. Gustav Bischof, Bonn, 1847 und 1848.

Method of chemico-geological inquiry.

the pseudomorphous minerals from which he derives the chief supports for the doctrine of an infinitely slow chemical alteration of the rocks, whereby we obtain a clear view into the disposition and operation of chemical processes within the crust of our globe.

The limits of this Report prevent us from examining farther into the contents of a work which, on account of its comprehensive and detailed character, does not admit of any abstract, and which, moreover, as the first source of geological chemistry, is presumed to be in the hands of every geologist and chemist.

Determination of the Component Parts of Rocks.—Delesse(1) has published a method by which the proportion by weight or volume of the constituents of a rock may be more easily and accurately determined, than by a laborious mechanical separation which, moreover, is not often practicable, on account of the trifling differences in the specific gravities of the various components. The method in question, however, is likely to be attended with great difficulties in practice, and moreover, to yield in most cases only an approximate result. It is founded upon the consideration, farther elaborated by Delesse, that in a rock of uniform mixture, the volumes of the component parts are to each other as their superficies $p, p', p'' \ldots$ visible upon a plane surface P (of a parallelopiped). The specific gravities $d, d', d'' \ldots$ of the component parts, as also D, that of the rock itself, being known, the equation $\frac{p\,d}{P\,D} + \frac{p'\,d'}{P\,D} + \frac{p''\,d''}{P\,D} + \ldots = 1$ furnishes the proportions by weight of the constituents; even the chemical composition of the rock might thus be calculated from that of the components according to the formula $A = \frac{p\,d}{P\,D}\,a + \frac{p'\,d'}{P\,D}\,a' + \frac{p''\,d''}{P\,D} + a'' \ldots$, in which A, a, a', a'' represent each a chemical constituent of the rock, and of the component parts. In order to determine the values of p, p', p'', P, Delesse lays upon a smoothly polished surface of the rock, previously moistened with oil (in order more distinctly to bring out the constituent parts), gold-beater's skin, or tissue paper, upon which he traces the outlines of the constituent parts. He now colours the drawing, fixes it with gum upon a piece of tin foil, and cuts the various constituents out with scissors. After the removal of the papers, the pieces are weighed, and thus p, p', p'', P are expressed in

(2) Arch. Ph. Nat. VI. 114; Ann. des Mines [4] XIII, 379, 686; Compt. Rend. XXV, 544 (in abstr.); Naumann's Lehrbuch der Geognosie I, 431.

weights. In this manner Delesse determined the composition by volume of the following rocks : Determination of the component parts of rocks.

Red Egyptian granite	43 A	9 B	44 C	4 D
Porphyry (partly) granite from Choly (Vosges)	45 E	2 F	52 C	1 D
Granular variety of the same	43 E, F		55 C	2 D
Porphyry granite (Vosges)	28 E	7 F	60 C	6 E
Porphyry granite (Vosges)	11 E	5 F	80 G	4 D
Syenite from the Ballon	18 A	36 H	46 I	
Another variety	17 A	34 H	49 I	
Coarse-grained diorite	62 K	38 L		
Nodular diorite (Corsica)	84 K	16 L		
Quartz-porphyry (Vosges)	11 E	73 M	13 C	3 N
Red antique porphyry	11 F	87 O	2 L	
Melaphyre (Giromagny)	35 P	62 Q	3 R	
Porfiro verde antico	43 P	57 S		
A variety of the same	42 P	58 S		
A variety rich in Labradorite	54 P	46 S		

A. Red orthoclase. B. White felspar of twin formation like albite. C. Grey quartz. D. Black mica. E. White orthoclase. F. Reddish oligoclase. G. Quartz forming a mass with the two felspars and some mica. H. Light yellow andesite. I. Quartz with hornblende and some mica. K. White albite with some quartz. L. Green hornblende. M. Light yellow quartz and felspathic mass. N. Pinite and mica. O. Chestnut-brown mass. P. Greenish Labradorite. Q. Dark violet-coloured mass. R. Calc-spar amygdaloid. S. Green mass.

Magnetism of Rocks.—Fournet(1) has published a treatise upon the magnetism of minerals and rocks, and upon the causes of certain anomalies in terrestrial magnetism; in this treatise, which is rich in new facts, the author has brought forward some proposals worthy of consideration, in reference to the mode of placing magnetical instruments.—According to Durocher(2) granite is rarely magnetic, but out of 38 specimens of diorite, trap, basalt, trachyte and lava, 34 affected the needle, a result which appears to be due to the presence of small quantities of protoxide of iron, of titanic iron, or of magnetic iron, although the greater number of non-magnetic stones also yield sesquioxide of iron when boiled with acetic acid, and assume a red colour on calcination.

Conducting-Power of Minerals for Electricity.—Rivot and Phillips(3) have published a series of experiments upon the electrical conducting-power possessed by the principal rocks at high temperatures; these researches promise to become of some geological

(1) Jahrb. Miner. 1848, 661.
(2) Compt. Rend. XXV, 208; Jahrb. Miner. 1848, 209.
(3) Ann. des Mines [4] XIV, 57.

Conducting-power of minerals for electricity.

importance in regard to the part which electricity acts in certain strata, and to its frequently rather sudden accumulation upon changes occurring in these veins; it is the intention of the authors also to extend their investigations to the conducting-power of the same rocks at low temperatures, when submitted to a high pressure, or exposed to the action of water. The greater number of the rocks and minerals composing the earth's crust, do not, when perfectly dry, conduct electricity at any temperature below a red heat. The only minerals in which any conducting-power is apparent at the ordinary temperature are some of the metallic sulphides, as lead-glance, iron pyrites, copper pyrites, sulphide of antimony, and magnetic-iron. A large number of minerals, however, possess considerable conducting-power for electricity when they are charged with moisture, or raised to a high temperature. Fire-clays in the moist state are conductors of electricity at the ordinary temperature, but if dried become non-conductors even when heated. This property was found to be very useful in the prosecution of the experiments, since the crucibles and fire-proof lining of the furnace did not affect the conducting-power of the substances submitted to examination.

For farther details we refer the reader to the treatise itself, and conclude by exhibiting the order in which these observers have ranked the various rocks according to their decreasing conducting-power.

1. Black hornblende. 2. Chlorite-slate, in a direction parallel to the cleavage. 3. To adstone. 4. Red porphyry. 5. Elvane from Cornwall. 6. Chlorite-slate, perpendicular to the cleavage. 7. Red porphyry, powdered and fused. 8. Black angite. 9. Felspar (orthoclase, albite, ryakolite). 10. Killas. 11. Mica. 12. Gneiss, granite. 13. Quartz, white and green augite, green hornblende, elvane from Freiberg. 14. Fire-clays, lime.

Fusibility of Minerals.—Delesse(1) has conducted a series of experiments possessing some geological interest, upon the fusibility of rocks. According to his observations, many minerals may be retained in a fused state for several days without attacking the sides of the crucible. This is, however, not the case with the rocks of volcanic origin, which not only powerfully corrode, but even perforate the substance of the crucible in which they are fused, a difference of deportment which explains the diversity in the composition of lavas, arising from their solvent action upon the adjoining rock. The surface of the crucible in contact with the fused mineral

(1) Arch. Ph. Nat. VI, 27; Compt. Rend. XXV, 545, (in abstr.); Instit. 1847, 339; Sill. Am. J. [2] V, 258; VI, 133; J. Pharm. [3] XIII, 68; Pogg. Ann. LXXIII, 454; Jahrb. Miner. 1848, 336.

CHANGE IN THE SPECIFIC GRAVITY OF VARIOUS ROCKS, WHEN PASSING FROM THE CRYSTALLINE INTO THE AMORPHOUS (GLASSY) CONDITION.

(To face II, page 456.)

	Rock.	Locality.	Water, per cent.	Spec. grav. of the rock.	Spec. grav. of the glass.
	Granite quartz-porphyry.				
1.	Granite, grain middling, rich in quartz, and containing here and there scales of mica	La Roche in Berny Côte d'Or)	—	2·622	2·321
2.	Fine-grained granite, rich in quartz, together with white orthoclase, oligoclase, and black mica	Voly (Vosges)	—	2·635	2·353
3.	Fine-grained granite	Vire (Calvados)	—	2·730	2·450
4.	Granite (Ch. Deville)	Bec d'Andoux	—	2·623	2·360
5.	Fine-grained granite	St. Honorine (Orne)	—	2·684	2·423
6.	Porphyry-granite of middling grain, with rose-red orthoclase	Flamanille (Manche)	0·26	2·680	2·427
7.	Fine-grained granite	St. Brieue (Côt. d. Nd.)	0·55	2·751	2·496
8.	Quartz-porphyry of a greenish-white fundamental mass, with crystals of quartz, and indistinct crystals of orthoclase	Montrenillon (Nièvre)	1·08	2·576	2·301
	Syenitic granite.				
9.	Syenite, with flesh-coloured orthoclase, white andesine, dark-green hornblende, and quartz	Ballon de Servance (Haute-Saône)	0·70	2·700	2·447
10.	Syenite, with brownish orthoclase, red andesine, dark-green hornblende, and quartz	Coravillers (Haute-Saône)	0·70	2·660	2·425
11.	Syenite, with brownish orthoclase, red andesine, dark-green hornblende, and quartz (another variety of the preceding kind)	Ibid.	0·70	2·643	2·478
	Granite-porphyry.				
12.	Granitic porphyry (Grüner)	Rochotte, near Faucogney (H.-Saône).	0·94	2·651	2·425
	Porphyry.				
13.	Red antique porphyry of chestnut-brown fundamental mass, with small crystals of rose-red oligoclase	Egypt	0·29	2·763	2·486
14.	Brown porphyry (E. de Beaumont)	Cemetery of Faucogney (Haute-Saône).	2·00	2·614	2·359
15.	White porphyry, fundamental mass of a potassa-albite and quartz, from the transition mountain	Auxelle-Haute (H. Rhin)	1·99	2·662	2·418
16.	Grey porphyry, of andesine-like fundamental mass	Chagey (H.-Saône)	2·34	2·764	2·514
17.	Brown porphyry, with indistinct crystals of felspar	Plancher-les-Mines (Haute-Saône)	1·01	2·633	2·423

	Rock.	Locality.	Water, per cent.	Spec. grav. of the rock.	Spec. grav. of the glass.
	Diorite.				
18.	Diorite-porphyry, with a beautifully dark-green fundamental mass, without quartz	Egypt . . .	1·81	2·921	2·679
19.	Coarse-grained diorite, with dark-green hornblende, without quartz	Château-Lambert (Haute-Saône) .	1·40	2·799	2·608
20.	Diorite of middling grain, with blackish hornblende, without quartz	Ibid. . . .	1·44	2·858	2·684
	Euphotide.				
21.	Variolite of Durance . . .	—	2·29	2·896	2·288
22.	Euphotide, with bluish felspar and emerald-green diallage . .	Rampans (Corsica) .	2·68	3·100	2·664
23.	Euphotide, with crystals of felspar and bronze-coloured diallage .	Mont-Genèvre . .	5·78	2·898	2·641
	Melaphyre.				
24.	Porphyry of Belfahy (melaphyre, of a blackish-green fundamental mass, and large greenish crystals of labradorite)	Belfahy (Haute-Saône) . . .	2·14	2·775	2·604
	Trachyte.				
25.	Rose-coloured, slightly crystalline trachyte (Ch. Deville) . .	Chahora-Mountain .	—	2·727	2·617
	Ancient volcanic rocks, basalts.				
26.	Ancient lavas of a pale, chestnut-brown colour, with crystals of anorthite	From the foot of Hecla . . .	—	2·844	2·718
27.	Black, dense basalt, with grains of olivine	Kaiserstuhl . .	—	2·931	2·814
28.	Basaltic lava (Ch. Deville) . .	Cône de l. Majorquin.	—	2·946	2·836
29.	Basalt of the Pic de Logo (Ch. Deville)	Cape-Verde Islands .	—	2·971	2·879
30.	Amygdaloid, with agates . .	Oberstein (Palatinate)	3·68	2·670	2·603
	New volcanic rocks, lavas.				
31.	Vitreous lava from the Peak (Ch. Deville)	From the Peak of Teneriffa . .	—	2·570	2·464
32.	New lava from the eruption in 1846, exhibiting a deep-blackish colour, grainy-crystalline texture and cavities . . .	Hecla . . .	—	2·762	2·678
33.	Dense, black obsidiane, with conchoidal fracture	Ibid. . . .	—	2·383	2·349
34.	Green lava (Ch. Deville) . .	Volcano of Chahora .	—	2·486	2·466
35.	Pumice-stone from the Peak (Abich)	Teneriffe . . .	—	2·477	2·456
36.	Obsidiane from the Peak (Ch. Deville)	Ibid. . . .	—	2·482	2·495
37.	Yellowish obsidiane (Ch. Deville)	Los Pedros Blancos .	—	2·383	2·476
38.	Minette (dark-brown, forming a vein, 50 centimetres in thickness, in syenite)	Ballon d'Alsace .	2·65	2·644	2·551

Fusibility of minerals.

is rarely corroded for more than a millimetre in depth, a lining resembling porcelain being formed. Hence it follows that the fused mass pretty generally exhibits the mean composition of the rock, a conclusion which Delesse has verified by several comparative analyses.

The glasses thus obtained by the fusion of various rocks, do not exhibit so great a difference in hardness as would be expected from their dissimilar composition. The glasses furnished by granite, granitic rocks, and quartz-porphyry, possess a degree of hardness which may be represented by 7, felspar-glass by 6, porphyry- and diorite-glasses by 6 (or somewhat less), euphotide, basalt, new lavas, "minetten" in apatite 5. In general, the hardness of the glass is proportionate to the amount of silica contained in the rock. The spec. grav. of the mineral, as is well known, diminishes; the results obtained by Delesse are given in the subjoined table.

It is the opinion of Delesse, that the water which is contained in almost all these rocks, and is expelled by fusion, exists in a state of chemical combination. Felspar containing water suffers a diminution in its spec. grav. by calcination, and thus the decrease of density in all rocks subjected to this process is in proportion to the amount of water, or of hydrated felspar which they contain.

The vitreous masses are usually of a more or less intense bottle-green colour, but the tint varies between black, green, and greyish-white, according as the felspar contains much or little iron. In some cases the glass is perfectly homogeneous, in others we may perceive throughout the mass small white particles of quartz, which remain undissolved though it be kept in fusion for several days, since quartz is dissolved with difficulty by silicates, even when long kept in contact with the incandescent liquid mass.

The author also describes the appearance of each of the glasses, for which we must refer to the original treatise; we content ourselves with remarking that many of the volcanic rocks very much resemble in appearance the artificial glasses obtained by their fusion, with which they also correspond in density, an observation which is intelligible if we consider that they may have cooled in nature with an equal degree of rapidity.

The chief conclusions to be deduced from these investigations are, that rocks, in their passage from the crystalline into the vitreous state, suffer a diminution in density which is, *cæteris paribus*, greater in proportion to the amounts of silica and alkali, and less in proportion to those of iron, lime and alumina. When the various rocks are arranged according to their decreasing specific gravity, the

Blue colour of water and ice.

oldest rocks generally occupy the first rank, and those of recent origin the last in the list, the diminution of specific gravity, moreover, bearing usually an inverse proportion to the fusibility.

Blue Colour of Water and Ice.—In the basins of the hot springs of Iceland lined with white siliceous incrustations, the water has a greenish-blue tint. According to Bunsen(1) pure water is blue, and all deviations from this colour arise either from the presence of impurities, or from the reflection of the light by the dark-coloured bottom of the wells. This may be proved by viewing any brilliant white object, upon a white ground, by the intervention of a layer of water of two meters in thickness contained in a tube blackened internally, or simply by allowing the sun-light to fall through such a layer of water upon a white object.

Formation of Veins of Ore.—Burat, admitting the continuity of all the various known veins of ore towards the interior of the globe(2), is of opinion(3), that the dissimilarity of the ores found in the upper and lower parts of the vein is not to be ascribed to a subsequent alteration of the original composition under the influence of the atmosphere, or of subterraneous water, by which, for example, the sulphides are converted into carbonates, phosphates, arseniates, &c.; he is inclined to believe that this conversion is effected in a great number of cases simultaneously with the origin of the veins of ore. Burat maintains, that if this alteration were really due to the first-mentioned cause, the same change would be everywhere apparent, which is not found to be the case. According to the same geologist, we cannot, by means of the former supposition, account for the phosphoric acid which in many cases has converted the veins of lead-glance to a depth of 60 meters into phosphate of lead. He ascribes these alterations to the combined influence upon the ore of subterraneous forces, and of sedimentary deposits, whilst the lower portions of the strata have been affected only by the emanations from beneath. This explanation the author especially applies to the beds of calamine on the Rhine and in Silesia, which have originated, according to Burat, from sedimentary deposits, in consequence of which the products of subterraneous emanation have been stratified with beds of clay.

The nature of these subterraneous emanations is the more changed,

(1) Ann. Ch. Pharm. LXXII, 44; upon this subject, and upon the blue colour of the Grotto of Capri, comp. Melloni in Arch. Ph. Nat. V, 321; for information with regard to the colour of glaciers, and of the water resulting from them, see I. 156.

(2) Ann. des Mines [4] XI, 27.

(3) Ann. des Mines [4] XIII, 235.

the farther they are removed from their source, and thus gives rise to the formation of the different zones which are distributed throughout the beds of ore. Formation of veins of ore.

Metallic sulphides, protoxides, and perhaps native metals compose the lowest of these zones with which we are acquainted, and which sometimes appears on the surface in the form of eruptive beds of ore, being distinguished by the compact and homogeneous structure of the masses. (Specular iron of the Island of Elba, magnetic iron of Taberg in Sweden, iron pyrites in the hornblende rocks of Tuscany and Norway, pure native metals in trap-formations, &c.).

A second zone is characterized by the crystalline and geodic state of its minerals, and by the variety of their species and the diversity of the rocky veins; almost all veins of ore are included under this zone. (Iron pyrites, fahl-ore, galena, blende, argyrythrose from the Hartz and many others). These veins are likewise formed by sublimation, recalling to our minds the effects of aqueous vapour in recent volcanic eruptions, and must be regarded as emanations from the subterraneous masses of the first zone.

In the third zone, closer to the surface, we meet with phosphates, arseniates, chlorides, the crystalline or hair-like native metals, and the earthy oxides of the so-called "gossan" of Cornwall. The mean thickness of this upper zone is 50 meters, the maximum being 100 meters; the thickness of the middle zone exceeds 800 meters, that of the lower has not yet been determined.

Petrifaction.— Marcel de Serres and Figuier(1) have discussed the conditions necessary for the petrifaction of animal substances; they must be immersed in water containing a large quantity either of lime-salts or of silicates.—The properties of the animal substances themselves are not without influence: when of a somewhat persistent nature, they are usually petrified by means of lime-salts, whilst with unstable substances the petrifaction is effected chiefly by silicates. The authors are of opinion that the process of petrifaction is still in operation, and in support of this view bring forward a number of observations made upon the shores of the Mediterranean, together with comparative analyses, which we here subjoin, of the shells of presently existing animals, as well as of recently petrified shells, and of such as are found in the upper tertiary formation. If shells are left upon the beach, they gradually undergo decomposition, but are not petrified. At a certain distance from the shore, the hollow and prominent parts of the surface are

(1) Edinb. New Phil. Journ. XLIV, 50.

Petrifaction.

worn down, and at length disappear, the sand collects and hardens in the cavity of the shell, smaller shells being sometimes accidentally inclosed. The calcareous mass, which, by the gradual process of substitution is ultimately precipitated throughout the whole substance of the shell, forms a centre of attraction for all the salts held in solution by the surrounding water, which are accordingly deposited in a crystalline state upon both the interior and exterior of the shells, forming crystalline cases of carbonate of lime frequently very regular in structure. Thus, the lime originally existing in the shells is dislodged and replaced again. All species of shells, however, do not suffer the same transformation. The shells of the oyster and the pecten, receive the petrifying solution chiefly between their lamellæ, and are thus strengthened, and more closely assimilated to stone than in their natural state; some of the shells with thin valves become covered with a species of calcareous cement, which fastens them together in the same way as it is seen in primæval shells. The *Ostrea edulis* is often covered with a crystalline coating of calc-spar which renders it as thick as those petrified in rocky masses.

When the process of petrifaction is complete, no vestige of the original structure of the shell remains. When shells, which have been thus petrified, are in contact with water containing organic matter in a state of putrefaction, their surface very often assumes a black or dark-blue tint, arising from the formation of sulphide of iron by the action of the reduced sulphates upon the sesquioxide of iron contained in the shells. In the same manner as the process of petrifaction is still in operation, the formation of the fossiliferous sandstone also proceeds without cessation. Masses of shell, more or less petrified, lying buried in the sand of the Mediterranean, are penetrated by a clay, under the influence of which they are hardened as if by Roman cement. Masses of metal, lying in the water, also form nuclei, around which the bases of the salts dissolved in the water, are aggregated with mussel-shells, sand, and the oxide of the metal, thus forming the basis of a rocky formation.

Petrifaction.

	Animal matter.	Carbonate of lime.	Carbonate of magne.	Sulphate of lime.	Phosphate of lime.	Sesquioxide of iron.
Ostrea edulis, living	3·9	93·9	0·3	1·4	0·5	trace
Ostrea edulis, recently petrified	1·5	96·3	0·1	0·7	..	1·4
Ostrea hippopus, upper tertiary formation	0·8	96·5	1·4	0·5	..	0·8
Pecten glaber, living	3·0	96·0	traces	0·7	0·3	traces
Pecten glaber, recently petrified	0·9	97·3	0·8	0·5	..	0·5
A *Pecten*, upper tertiary formation	0·7	96·7	0·4	0·8	..	1·4
Venus virginea, living	3·0	96·0	traces	0·3	0·1	traces
Venus virginea, recently petrified	0·6	99·2	..	0 2	..	..
Venus similis, upper tertiary formation	1·0	97·9	..	0·6	..	0·5
Pectunculus glycimeris, and *flamulatus*, living	2·4	97·2	traces	0·4	..	traces
Pectunculus glycimeris, and *flamulatus*, recently petrified	0·7	99·0	..	0·3	..	..
Pectunculus pulvinatus, upper tertiary formation	0·8	98·4	..	0·4	..	0·4
Cardium tuberculatum, living	2·0	97·8	traces	0·2	..	traces
Cardium tubercul. recently petrified	0·8	98·7	traces	0·5	..	traces
A *Cardium*, upper tertiary formation.	0·5	98·8	0·1	0·3	..	0 3

Kuhlmann(1) endeavours to explain the infiltrations of silica into fossil shells, by assuming that the decomposition of the alkaline silicate existing in all limestones, and in a number of other rocks, is not effected solely by the carbonic acid of the air, but also by the carbonate of ammonia which results from the decomposition of the inhabitant of the shell. He suggests, that the ammonia, after having parted with its carbonic acid to the base of the alkaline silicate (thereby effecting the separation of the silicic acid), may possibly continually withdraw carbonic acid from the atmosphere.

Zinc-Spar as a Petrifying Agent.—Müller, of Aix-la-Chapelle(2), has observed an agent of petrifaction hitherto unnoticed; coral of the limestone of the Eifel, is petrified by the zinc-spar of the calamine-mines at the Herrenberg, near Stolberg. Nöggerath(3) cites, in addition, several similar instances from Tarnowitz, and the mines of Stolberg.

Formation of Compact Rock from Infusoria.—Ehrenberg(4) has published an observation tending to throw light upon the conversion of loose strata of infusoria (siliceous sinter) into compact rock, and

(1) Compt. Rend. XXIV, 263.
(2) Verhandlungen des naturhist. Vereins der Preuss. Rheinl. 1848, 143.
(3) Ibid. 1848, 144.
(4) Berl. Acad. Ber. 1846, 158; Jahrb. Miner. 1847, 115.

Formation of compact rock from Infusoria.

especially into common opal (semi-opal) without the co-operation of high temperatures. On examining a large specimen of *Pinnularia Rhenana* from the Rhenish brown-coal of Rott and Geistingen, he found it traversed by many eye-like concentric rings which must have originated in the cellules of the Pinnularia, in a similar manner to the agate-formations in the amygdaloid. In some cases the entire shells were filled with these concentric rings, sometimes there were only a few to be seen in the inner chamber. "In the vicinity of the stratified common opal occurring in that neighbourhood, these rings appear even in those portions in which that fusion has commenced, which characterizes common opal." Of incrustations and ordinary sinters there is no vestige to be seen; the occurrence of the process in well-preserved strata of brown-coal altogether excludes the intervention of high temperatures.

Influence of Cementation upon the Hardening of Rocks.—Kuhlmann's(1) researches respecting the existence of potassa and soda in the limestones of different geological epochs, particularly in the varieties of hydraulic lime, and in many other rocks, are, to a certain extent, a continuation of the older valuable experiments of Fuchs. These researches are possessed of great geological interest, since they exhibit the importance of the cementing process in the production and hardening of rocks and minerals, explaining and illustrating by actual experiments the mode of agglutination of conglomerate, breccia, and other similar formations. According to Kuhlmann's views, the presence of alkalies is highly important, though not absolutely essential to the formation of a silicate of lime. Chalk, moistened with a solution of an alkaline silicate, is partly decomposed, with formation of silicate of lime, and alkaline carbonate; chalk and gypsum, in contact with solution of manganate of potassa, become impregnated with sesquioxide of manganese, and acquire considerable hardness, whilst small dendrites of the sesquioxide appear upon their surfaces, just as on natural minerals, marls, &c. Some oxides even, in their affinity for lime, exhibit the comportment of acids; Kuhlmann found this affinity sufficiently powerful to enable lime to decompose the alkaline combinations of these oxides. The silicate of lime which accompanies chalk, traversing it in many veins, probably arises solely from the infiltration of a solution of silicate of potassa, or of soda. The presence of some potassa in the chalk gives great weight to this opinion. The infiltration of silicic acid, and its crystallization

(1) Ann. Ch. Phys. [3] XXI, 364; J. Pr. Chem. XLII, 436; Arch. Ph. Nat. VI, 330; Compt. Rend. XXIV, 263.

in limestone, the formation of siliceous and aluminous cements, of flint, agates, petrified woods, and similar substances, depend upon the same reaction.

Influence of cementation upon the hardening of rocks.

In these formations, the gradual desiccation and contraction of the silicate of lime, which at the moment of its formation exists in the gelatinous form, appears to play a most important part; this action is, however, supported by the carbonic acid of the atmosphere, or that existing in the water, under the influence of which, the silicate of potassa is converted into carbonate. Whenever potassa is present in alumina, it appears that by contact of air a similar effect is produced, the alumina precipitated by the carbonic acid acquiring, by gradual contraction, a considerable degree of hardness.

In many cases the silicates of lime and magnesia, produced by the decomposition of the earthy carbonates under the influence of silicates of potassa and soda, when exposed to the action of waters impregnated with carbonic acid, or alkaline bicarbonates, part with their bases, silica remaining behind.

Metamorphism.—Incidentally to an investigation of the rocks of the Vosges, Fournet(1) has submitted to a careful examination of the changes induced by the influence of plutonic rocks, from which he concludes that the stratified masses of the Vosges have, in part, floated on the rocks while in a state of igneous fusion, and that a mutual action has been exerted between the two. Fournet designates the case in which the stratified rock has suffered alteration by the term *exomorphism*, while that in which the plutonic rock itself has been changed, he calls *endomorphism*. He distinguishes as:

Exomorphic rocks:	*Endomorphic rocks:*	*Normal eruptive rocks:*
Slate, modified sandstone,	Porphyry, modified by slate	Quartz-porphyry,
Green porphyry,	and sandstone,	Granitic porphyry,
Black porphyry,	Claystone-porphyry,	Red eurite.
passing into	Brown porphyry.	

For farther details we must refer to the original treatise.

Haidinger(2) has published some elaborate observations upon the metamorphism of rocks, which he founds upon the principles of the electro-chemical theory. The foundations of his view are the pseudomorphoses of those mineral species which are allied to various classes of rocks by their geognostic position. He arranges them in two groups. In the one group he assumes an electro-positive altera-

(1) Bullet. de la Société Géolog. de France [2] IV, 220; Arch. Ph. Nat. V, 293.

(2) Haidinger's Berichte (comp. II, p. 379) IV, 102, 211; Haidinger's Abhandl. I, 305; Wien. Acad. Ber. II. Hft. 123; Jahrb. Miner. 1849, 213.

Metamorphism.

tion, a reduction, corresponding to the cathode, which is induced by the moisture and mineral solutions, pervading all rocks; they are termed by Haidinger *cathogenous pseudomorphoses;* in the other class, an oxidation, or electro-negative alteration takes place, corresponding to the anode; these are styled *anogenous pseudomorphoses*. In the deposition of dissolved constituents into free spaces, drusic cavities, or veins, Haidinger admits the operation of an infiltration, a species of transpiration, but not of an instillation. The nature of the water, and of the substances deposited from it, in the course of time, must have frequently changed according to the geological position of the rocks. The motion of the substances dissolved follows the direction of the current, but is also influenced by chemical affinity. On the surface of the earth the oxidizing process is in operation, whilst remote from it, the process of reduction is prevailing; in certain of the deeper strata the potassa seems to recur, whilst other substances disappear, whereby the formation of potassa-mica, instead of cordierite, in granite, is explained. For the various rocks there must be assumed, according to Haidinger, beneath the surface of the earth, a line or plane at which the operation from the surface meets with that of the heated interior, and which must vary considerably with the different chemical changes taking place. This plane is called by Haidinger the *horizon of reaction,* or the *line of reaction,* in allusion to the definition of volcanic phenomena given by Humboldt.—In order to illustrate these antitheses in the transformations, Haidinger adduces iron in its various stages of oxidation and sulphuration; the limits of this Report, however, will not permit our following him into details. In the formation of red clay-strata, red slate, and red porphyry, we must assume as the horizon of reaction the limit at which the hydrated sesquioxide of iron loses its water; all the rocks below this level are anhydrous and of a red colour, whilst all those above it still contain water. According to Haidinger, the horizon of reaction for the formation of sesquioxide of iron determines with tolerable accuracy the lower limit down to which hydrated rocks occur. Since, however, the pressure steadily increases from the surface downwards, we have to assume a corresponding horizon situated closer to the surface, and representing the maximum of water present in the rocks. It is in this place that, according to Haidinger, its affinities are probably most active, and here Scheerer's polymero-isomorphous combinations may possibly be produced, if the existence of such combinations must be admitted. It is here that the water displaces other substances which are carried away by the moisture descending in the rocks; this also may be looked upon

as the seat of the formation of mineral springs, &c. When, in the process of dolomitization, f. i., the formation of sulphate of lime just ceases at the limit of these influences, we shall find anhydrite in the lower part, and gypsum in the upper, as the products of this dissimilar operation. The saline solutions existing in this neighbourhood, also dissolve a part of the silica, which has been converted into the soluble modification by the reaction in the interior, and which we are not surprised to find again deposited in the form of veins of quartz and similar minerals. The same influence also explains the concretion of the sandstone, since its continual operation removes the bases, surrounding as it does, at the same time, and cementing the particles with siliceous matter. Metamorphism.

Decomposition of Rocks by Water.—W. B. and H. E. Rogers(1) have conducted a series of researches into the decomposition and solution of various rocks and minerals by pure water and carbonated water, a subject upon which experiments had been made at an earlier period by Struve, Forchhammer, Wiegmann and Bunsen. The American chemists have used in their investigation two different methods: 1. The powdered mineral was washed for a short time upon a filter, and a drop of the filtrate examined. 2. About 40 grns. of the powdered mineral were introduced into a flask, and agitated from time to time with 10 cubic inches of distilled water, or of water saturated with carbonic acid at $15^{0}{\cdot}5$. The substances subjected to experiment were the felspars, mica, leucite, analcime, mesotype, scholezite, schorl, greenstone, chalcedony, obsidian, lava, gneiss, hornblende-slate, soils, chlorite, talc, serpentine, steatite, olivine, hypersthene, hornblende, actinolite, tremolite, augite, asbestos, coccolite, massive and crystallized epidote, axinite, prehnite, brown garnet, dolomite, flint-glass, green bottle-glass, green German glass, white Bohemian glass, Wedgwood ware, Chinese porcelain, anthracite, bituminous coal, lignite, wood-coal, ashes of wood and coal, and different specimens of wood. When treated according to the first of the above methods, all the minerals and glasses were partly decomposed and dissolved by carbonated water, and with few exceptions, even by pure water. By the second method, an amount of the substance, sufficient for a quantitative analysis, was dissolved, when the mineral was treated with carbonic acid water during forty-eight hours, or subjected to the action of distilled water for a week. In this manner a quantity of matter varying from 0·1 to 0·4 of the mass employed, was dissolved

(1) Sill. Am. J. [2] V, 401; Jameson's Journ. XLIX, 163; Jahrb. Miner. 1848, 740 Dingl. Pol. J. CIX, 436.

Decomposition of rocks by water.

from hornblende, actinolite, epidote, chlorite, serpentine, felspar, mesotype, &c.; the substances found in solution were lime, magnesia, sesquioxide of iron, alumina, silica and alkali; the lime, magnesia and alkali, in the form of carbonates; the iron of the hornblende, epidote, &c. also in the state of carbonate, but passing, during the evaporation of the solution, into sesquioxide which is collected, together with the alumina and silica, in brown flocks at the bottom of the vessel. Thus, 40 grns. of hornblende, digested for forty-eight hours, and repeatedly agitated with carbonated water at 15^0, furnished 0·08 silica, 0·05 iron, 0·13 lime, 0·95 magnesia, and a trace of manganese. Most of the above-named minerals, when powdered in an agate mortar and moistened with water, exhibited a perceptible alkaline reaction. Silicates of magnesia and of magnesia-lime are very easily attacked by carbonated water, and even by pure water, an observation which explains in a very simple manner the facility with which plants extract lime and magnesia from soils containing the silicates of these bases.

Anthracite, bituminous coal, and lignite, when treated according to the first method, yield distinct proof of the presence of alkali, which, however, cannot be detected in their ashes, a circumstance which must be attributed to the high temperature at which these ashes are produced, and not to the want of alkalies in the coal. By rubbing wood to a fine powder with carbonic acid water, the alkalies and their carbonates which exist in the plant may be detected, whereas the volatility of these substances is so great, that by incineration at a strong red-heat, it frequently may happen that scarcely half the quantity of alkali is actually obtained (?).

Influence exerted upon the Nature of the Constituents of Well-Waters by the Height of their Source, and the Nature of the Stratum in which they occur.—Grange(1) has made comparative analyses of the waters of the talc-, anthracite-, and chalk-strata of the valley of the Isère; the results obtained present several points of interest. The absolute quantity of the salts dissolved in the water increases as we descend from the summit of the mountain to the plain, whilst their relative quantities suffer considerable variation. The soluble salts, chiefly chlorides, diminish in quantity as we descend, whilst on the other hand the insoluble, or sparingly soluble salts, gypsum and carbonate of lime, increase. The relative quantities of the chlorides, sulphates and carbonates vary in the springs of the three strata. In the talc-stratum the chlorides predominate, varying from 25 to 32

(1) Ann. Ch. Phys. [3] XXIV, 464.

per cent, in the anthracite-stratum they do not amount to more than from 10 to 16 per cent, and in the chalk they form only 4 to 8 per cent of the total solid matter contained in the water.—The quantity of the sulphates is nearly equal in the chalk- and anthracite-strata, varying, in the former case, from 24 to 31, and in the latter from 18 to 37 per cent of the dissolved salts. In the Néocomien they amount only to from 5 to 12 per cent.—The carbonates vary from 36 to 47 per cent in granitic soils, from 48 to 71 in the anthracite, and from 83 to 88 per cent in the chalk-stratum.—The soda-salts (chloride and sulphate) predominate in the talc, and especially in the anthracite; the absolute amount of sulphates in this last stratum is much the highest.—The magnesia-salts exhibit a remarkable constancy in the talc- and anthracite-strata; their relative quantity varies from 19 to 23 per cent of the dissolved matter in granitic rocks and slate, and from 11 to 23 per cent in the anthracite.

The geological nature of the strata explains these peculiarities. It may be quoted in conclusion that all springs occurring on the boundary-line of granitic rocks and calcareous clay-slate are very rich in magnesia, a circumstance attributable to the quantity of gypsum and dolomite invariably found in such localities.

G. Bischof(1) has analysed the water of thirty-three mineral springs in the neighbourhood of the Lake of Laach, and of thirty-eight fresh water springs, arising partly from the crystalline rocks of the Siebengebirge, partly from the porphyry of Münster, near the Stein and the Donnersberg, and the rest from the granite beneath Heidelberg at Schriesheim and Weinheim. This analyst finds that in all these cases, carbonate of soda is the predominating salt; sulphate of soda and chloride of sodium are invariably present, but in much smaller quantities. The salts held in solution by free carbonic acid, are the carbonates of lime, magnesia, and protoxide of iron. All these springs exhale more or less carbonic acid gas. The difference of height, at which the springs in the neighbourhood of the Lake of Laach occur, varies from 500 to 800 feet, and the fixed constituents, especially the soluble salts, diminish as the elevation increases. In general, those springs which contain most fixed constituents are the deepest and warmest, although no direct relation is observed between the solid contents and the temperature. The same rule holds good also in the Eifel, in Nassau, and in Auvergne. The mineral springs of deep valleys are the richest in soluble consti-

(1) Verhandlungen der niederrhein. Gesellschaft für Natur- und Heilkunde zu Bonn 5 Nov. 1846; Jahrb. Miner. 1848, 624.

Well-waters.

tuents; whilst the greater number of carbonated springs issuing at high levels contain chiefly earthy carbonates, and carbonate of protoxide of iron, with but a small quantity of soluble salts.

The qualitative examination of the above-mentioned fresh-water springs was performed in order to obtain some information respecting the salts contained in the basalt, dolerite, trachyte, porphyry, and granite of these districts. Bischof found that the chief constituents of these waters are the chlorides of calcium, magnesium, and sodium, while gypsum is not found to occur except in the springs which have partly passed through sedimentary rocks. The basalt of the neighbourhood of the Lake of Laach contains in addition to chloride of sodium, chiefly sulphate of soda which invariably predominates in the rocks supplying the mineral springs of Bohemia. Bischof observes that the fresh water from the porphyry of Münster at the Stein contains the same chief constituents which are found in the waters of the Lake of Laach, and in the brine of Kreuznach, and believes that the latter waters also derive their salts from the porphyry. It has been long known that these waters are free from gypsum, which is invariably found in other analogous cases. The author shows that the salts contained in sea-water have originated from the action of atmospheric waters upon the rocks; he adduces calculations in support of this view, for which we refer to his work, which we have quoted in the commencement of this Report upon Chemical Geology.

M. J. Vogel(1) discusses the relation which exists between the formation of mineral springs, and the metamorphosis of rocks; he is of opinion that the mineral waters formed close to the surface of the earth, far from being solely products of exhaustion, must rather be considered as integral links of the general process of metamorphosis, inasmuch as they appear successively, as cause, or effect, or co-effect of this process. The author, referring to Haidinger's distinction of anogenous and cathogenous metamorphosis, considers as anogenous those mineral springs which are formed in the upper strata, and in which lime, gypsum, magnesia, alumina, common salt, sulphuric and hydrosulphuric acids chiefly occur, while the mineral and thermal waters, produced by the reductions of the cathogenous metamorphosis are designated cathogenous mineral springs. The former derive the comparatively small quantity of carbonic acid they contain, from the percolation of atmospheric waters through the crust of humus, and from the transformation of siderose

(1) Haidinger's Berichte (comp. II, 379) IV, 436, 448; Jahrb. Miner. 1849, 318.

Well-waters.

into the hydrate of the sesquioxide; they contain lime, magnesia, and iron, chiefly in the form of bicarbonates, produced by the action of their carbonic acid, but also in the form of neutral carbonates. As to the latter class, the author is not of opinion, that they *generally* are produced under the influence of processes allied to volcanic actions.

Evolution of Gases in Mines of Metalliferous Ores.—Daubrée(1) has communicated some observations respecting gas-explosions in the iron-mines of Gundershoffen and Winkel, and in a copper-mine of Giromagny, all former instances having occurred in coal-mines. Although in such mines as that of Giromagny, in which iron-pyrites and blende are present, or as those of Gundershoffen and Winkel, where the iron is but imperfectly oxidized, a gradual decomposition of water may be assumed, which would give rise to the liberation and collection of hydrogen, the author is more inclined to attribute such explosions to the accumulation of marsh-gas which may be derived, in Gundershoffen from the bituminous lias marls, upon which the bed rests, in Winkel from the bituminous jurassic strata, and lastly, in the transition-formations of Giromagny from the anthracite-strata of the adjacent rocks.

Fr. Schneider(2) has likewise communicated an account of an explosion of fire-damp in mines of metalliferous ores, namely, in the Mathias-Büttnergründel mine, near Felsö-Slovinka, by which four miners lost their lives. He ascribes the accumulation of the explosive gases to the interruption of the ventilation occasioned by the breaking down of a culvert. The gases were probably generated by the decomposition of the drainage-water under the influence of putrifying timber, and perhaps also by the presence of iron pyrites.

Volcanic and Pseudo-volcanic Phenomena.—A very complete synopsis of volcanoes, of earthquakes, and hot springs is found in the second edition of Daubeny's(3) work on volcanoes.

Bunsen(4) has communicated his ideas respecting the formation of the thermal springs, fumeroles and solfataras of Iceland, together

(1) Ann. des Mines [4] XIV, 33; Compt. Rend. XXVI, 98 (in abstr.); J. Pr. Chem. XLIII, 398.

(2) Haidinger's Berichte (comp. II, 379) III, 224; Jahrb. Miner. 1849, 331.

(3) A description of active and extinct volcanoes, of earthquakes and of thermal springs, with remarks on the causes of these phenomena, the character of their respective products and their influence on the past and present condition of the globe. London, 1848.

(4) Ann. Ch. Pharm. LXII, 1. Chemical Reports and Memoirs, Ed. by Thomas Graham, Cavendish Society's Works, Vol. I, 323.

Volcanic and pseudo-volcanic phenomena.

with a perfectly new explanation of the Geyser, and the other springs of that island. He points out an intimate connection between these springs and the active volcanoes; both follow one direction, namely, that of the principal valleys, the elevated ridges, and the numerous volcanic fissures.

The basis, upon which Bunsen's theory is founded, is the relation existing between the palagonite-mountain and the plutonic masses which have penetrated through it, and still continue to penetrate it during the eruption of volcanoes now active, in the form of currents and strata of lava.

The palagonite-tuff(1) is the most ancient member of this series of formations, which immediately preceded the elevation of trachyte and of clinkstone. The older trap, a doleritic rock, which is transformed into various kinds of amygdaloid, characterizes the third period of elevation, during which the rock was upheaved in large veins, and frequently spread itself laterally in far extended parallel strata through the tuffaceous masses. To the fourth period appertain the basaltic elevations rich in olivine, while the fifth period of the older and more recent lavas closes the series of plutonic elevations.

Formation of the Springs.—The springs derive their origin from the meteorological deposits upon the elevated plateau, or from the water of the glaciers. The dykes and fissures corresponding with this volcanic line of elevation must necessarily interrupt the course of these subterranean waters, and conduct it to a depth, where, by the action of the volcanic soil, they are heated and converted into steam. The water elevated by the combined force of elastic vapour and hydrostatic pressure, then breaks forth in lines of thermal springs, which have mostly a north-eastern direction.

Presence of Nitrogen in the Springs.—That it is from meteoric depositions that the water is conveyed to these springs, is clearly proved by the escape of nitrogen, either pure or mixed with other gases, from the boiling fountains; the amount of this nitrogen *never exceeds the proportion contained in the atmospheric air diffused through the water*. The springs contain, moreover, invariably a small quantity of ammonia-salts, and organic extractive matters. These observations do not, however, in any way exclude the possibility that the great quantity of water contained in the

(1) Respecting palagonite, which forms a mineral species (Ann. Ch. Pharm. LXI, 265), we refer also to our Mineralogical Report II, 419; to Sartorius von Waltershausen's Memoirs on the Submarine Volcanic Eruptions of the Val di Noto in the Göttinger Studien, Gött. 1845, 402; and to Sandberger's, geol. Verhältnisse des Herzogth. Nassau, Wiesbaden, 1847, 81.

palagonite of the tuff-strata may perform an active part in the disengagement of vapours from the suffiones, from the hot springs, and from the volcanoes of Iceland. This water (17 per cent) is capable of generating a quantity of vapour, which at 0^0, and $0^m{\cdot}76$ occupies 512·7 times the volume of the original rock.

Presence of nitrogen in the springs.

Mineral Constituents of the Springs.—The mineral constituents of the waters arise from a reciprocal action of the originally pure water, and of the volcanic gases dissolved in it, upon the rock constituting the base of the spring, which in most cases is palagonite. The Iceland mineral waters are distinguished by the proportionally large quantity of silica which they contain; and if we except the acidulous springs which are confined to the western part of the island, we may divide the springs into two main groups, one of which would comprise the acid, and the other the alkaline silica-springs. The former belong to the actual solfataras, and owe their slight acid reactions more commonly to the presence of small quantities of ammonia-, soda-, or potassa-alum, than to minute traces of free sulphuric and hydrochloric acids. They contain, moreover, sulphates and chlorides of calcium, sodium, potassium, and iron, also silica and sulphurous acid, or in the place of the latter hydrosulphuric acid. They are especially characterised by depositions of gypsum and sulphur, but form only rarely periodic springs of eruption.—The alkaline springs are the most prevalent, and constitute the periodic bubbling-springs, as well as the majority of the warm and boiling springs. Their extremely slight alkaline reaction is owing to the presence of alkaline sulphides, and the carbonates of potassa and soda, serving as solvents for the silica, and giving rise to the siliceous-tuff formations, by which these springs are so strongly characterised. Alkaline sulphates and hydrochlorates, together with traces of magnesia, are almost invariably found in these waters.

Volcanic Gases.—The volcanic gases which re-act upon the palagonite of Iceland are sulphurous and hydrosulphuric acids, together with carbonic and hydrochloric acids, the latter in smaller quantity.

The nitrogen originally belonged to the atmosphere or to organic bodies, a view remarkably supported by the observations made respecting the formation of sal-ammoniac in the neighbourhood of Hecla; this formation, under the influence of new lava-torrents, was found to be limited to the zone in which the meadow land was overflowed by the lava(1). The large fumeroles of the back of the

(1) Sartorius von Waltershausen (physisch-geographische Skizze von Island. Abdruck aus den Göttinger Studien, 1847), contests the opinion of Bunsen respect-

Volcanic gases.

crater, and even of the four new craters, yielded only sulphur, hydrochloric and sulphurous acids, without exhibiting the slightest trace of ammoniacal products.

The aqueous solution of sulphurous acid which rises from the hot soil dissolves the palagonite, the sesquioxide of iron being reduced, with the formation of the protoxide and sulphuric acid; the oxidation of sulphurous acid is likewise effected in part at the surface of the fumeroles, by the action of the atmosphere, or in their depths by the atmospheric oxygen diffused in the spring water. The sulphuric acid thus generated is distributed amongst the constituents of the palagonite, which are liberated together with a portion of silicic acid, and appear as sulphates in solution. This process represents the first stage of the fumerole action, in which sulphurous acid, hydrosulphuric acid, sulphur and steam bursting forth from the soil, spread themselves far over the sulphur-fields, or a bluish-black boiling argillaceous paste rises in huge bubbles. Analysis, however, shows that the ratio in which the bases occur in the acid silica-springs differs essentially from the relation existing between the constituents of palagonite, proving that the activity of the chemical decompositions induced by the sulphurous acid does not end with the solution of the palagonite(1). The whole amount of protoxide of iron, together with a quantity of alumina and lime are again removed from the solution. Bunsen found that palagonite possesses the property, on being digested with a neutral solution of sulphate of iron, of precipitating the protoxide of iron as a hydrate, or perhaps as a silicate, with formation of sulphate of lime. Free sulphurous acid, therefore, originally dissolves the sesquioxide of iron of the tuff as a salt of protoxide, together with a portion of the remaining constituents; but when the solutions have been neutralized by their passage through the rock, and remain still longer

ing the organic origin of the sal-ammoniac in the Iceland fumeroles; he believes that it is owing to the presence of ammonia in the atmosphere. Bunsen has pointed out (Ann. Ch. Pharm. LXV, 1,) the insufficiency of the arguments adduced, although he does not dispute the possibility of a formation of chloride of ammonium from the ammonia of the atmosphere in the presence of hydrochloric acid. (Bunsen and Playfair, Report on the Gases evolved from iron furnaces. Mem. of Brit. Assoc. 1845).

(1) This is very evident, if we compare the relation of the bases in palagonite with that of the bases occurring in the water of the suffiones. Bunsen found in 10000 parts of water taken from one of the largest boiling mud-cauldrons of the Reykjahlider Solfatara, between the north-eastern declivity of the Námarfjall, and the Burfell lava stream, 1·2712 sulphate of lime, 1·0662 sulphate of magnesia, 0·7333 sulphate of ammonia, 0·3261 sulphate of alumina, 0·2674 sulphate of soda, 0·1363 sulphate of potassa, 0·4171 silicic acid, 0·0537 alumina, and 0·0820 hydrosulphuric acid (Ann. Ch Pharm. LXII, 1). Comp. also Damour's Analyses, II. 266).

in contact with it, the iron is deposited again as hydrated protoxide, or, if oxygen be present, as hydrated sesquioxide. The decomposed palagonite is thus converted into alternate and irregularly penetrating beds of white fumerole clay, free from iron, and of the coloured ferruginous variety. The limits of these deposits indicate the strata, where the first action of acid solutions has passed into the second one of neutral solutions. These beds of clay greatly resemble certain structures of the keuper-formation, and we have thus reason to believe that the alternate colours of the strata in the latter are due to the successive chemical metamorphoses of the same rock, and not to its having been deposited from water.

Formation of Gypsum.—The same action which is exercised by palagonite on a neutral solution of sulphate of protoxide of iron, occurs also in the sulphates of alumina and of sesquioxide of iron. The neutral solutions of both these bases are precipitated by it with formation of sulphate of lime; and the alumina is not only separated in this manner from the suffione-waters, but also transported from one part to another within the sphere of these decompositions, a circumstance which sufficiently explains the inequality and great variety in the composition of the clay-strata. The sulphate of lime of these decompositions perfectly agrees with the gypsum-strata occurring in the marls and clay-structures of the lias formation, the perfect absence in which of calcareous shells appears to point out that they have been exposed to the action of acid vapours; these fumerole-actions throw, moreover, a great deal of light upon the relation existing between the tertiary clay-formations, and the tuff of basalt, dolerite, and trachyte.

Formation of Alum.—Among the products generated by the activity of the solfataras in Iceland, we have still to notice plumose alum, iron-pyrites, copper-pyrites, sulphate of copper, and sulphur itself. The formation of plumose alum takes place at the surface of the fumerole-clay, and is limited to periods when a dry atmosphere favours the efflorescence of this salt on the ground. We find it most frequently deposited upon the smoking mud-crust, and it may be plainly seen that the remarkable property possessed by palagonite to precipitate neutral solutions of alumina, must limit the formation of this alum to those localities where a constant flow of acids, more particularly of sulphurous acid, is kept up by the action of the fumeroles.

Hydrosulphuric acid which accompanies the gaseous exhalations of these suffiones, when in contact with the porous fumerole-clay experiences a combustion at the expense of the oxygen of the atmosphere, the chief product of which is sulphuric acid. The rain-

Separation of sulphur.

water dissolves the salt newly formed, and carries it down to the strata of palagonite, which precipitate the alumina.

Separation of Sulphur.—The separation of sulphur at the mouths of the suffiones appears to be essentially due to the reciprocal action of sulphurous and hydrosulphuric acids in the presence of steam, or to a decomposition of the latter by the oxygen of the atmosphere(1).

Formation of Iron-Pyrites.—The formation of iron-pyrites depends upon the decomposition which the substance of the palagonite undergoes under the influence of hydrosulphuric acid, protosulphide of iron and an alkaline sulphide being produced. The palagonite is converted by the former into a black mass which imparts a bluish-black colour to the clay of the boiling mud-pools, and is not unfrequently manifested in the springs by the deposition of a sandy-black powder. The alkaline sulphides, on the contrary, are dissolved by the boiling water, and converted, wherever they come in contact with sulphur, into polysulphides. The latter are distinguished by the facility with which they dissolve small quantities of protosulphide of iron which, under peculiar circumstances, is deposited again. It will, therefore, be easily understood, how sesquioxide of iron, converted into protosulphide by the action of hydrosulphuric acid, with the separation of sulphur, may be dissolved by the simultaneously formed alkaline polysulphide, and, abstracting from the latter 1 equivalent of sulphur, be again precipitated in crystals of bisulphide of iron, as iron-pyrites.

Alkaline Siliceous Springs.—Bunsen(2) has made a series of numerous experiments, in order to ascertain the origin of the alkaline silica-springs; for the same purpose he induced Sandberger(3) to analyse the water of the Great Geyser. He arrived at the general fact, that none of the rocks of which the island is formed resists the decomposing action of the thermal waters, which convert them into

(1) Haidinger [Bericht. (comp. II, 379) II, 399] assumes that the formation of clay, brown iron-ore, &c., occurring together with native sulphur, near Kalnika, in the neighbourhood of Végles and Altsohl, in Hungary, is perfectly analogous to that of the clay, sulphur, &c., in the solfataras of Iceland. The only difference is, that in Hungary the changes have taken place in trachyte and diorite, and that the process is manifested in a later stage.

(2) Ann. Ch. Pharm. LXII, 48. Extract of a letter addressed by R. Bunsen to J. J. Berzelius, Marburg, Nov. 1846; Augsb. Allgem. Ztg. 24 Dec. 1848.

(3) Sandberger found in 1000 parts of this water 0·5097 silica, 0·1939 carbonate of soda, 0·0083 carbonate of ammonia, 0·1070 sulphate of soda, 0·0475 sulphate of potassa, 0·0042 sulphate of magnesia, 0·2521 chloride of sodium, 0·0088 sulphide of sodium, 0·0557 carbonic acid (Ann. Ch. Pharm. LXII, 49). Comp. Damour's analyses, II, 266.

acid and basic silicates. The former are dissolved by the water, while the latter remain in the form of insoluble beds of clay. The soluble silicates are brought to the surface with the water, giving rise, where it is left to evaporate, to the formation of siliceous sinters and opals. The palagonite-tuff stands in the most intimate relation with the formation of geysers. On digesting pulverized palagonite with distilled water for some hours, at a heat of 100^0 or 106^0, we find that 1000 grms. of water dissolve 0·03716 silicic acid, 0·00162 of potassa, and 0·00824 of soda. On allowing water, saturated with carbonic acid, to act upon the pulverized mineral, all the constituents, with the exception of alumina and sesquioxide of iron, will be dissolved in the form of bicarbonates. Pulverized palagonite, when heated for ten hours with water, saturated with hydrosulphuric acid, gives rise to the formation of a solution of silicic acid, of the hydrosulphates of sulphides of calcium, of magnesium, of sodium and potassium, protosulphide of iron being formed at the same time. Hence we see, that the constituents of palagonite take very different parts in the decomposition which is induced by hot water, carbonic acid, and hydrosulphuric acid respectively. The alkaline siliceous springs, in which there is a smaller quantity of sulphurous acid, assume a very different character from the waters of the suffiones, for it is evident that the composition of the water, and the nature of the argillaceous deposits produced by these actions, must stand in a definite relation to the greater or smaller resistance opposed by the separate constituents of palagonite to the influence of the weaker volcanic acids, that is to say, to water, carbonic acid, and hydrosulphuric acid.

Alkaline siliceous springs.

When the alkaline silicates, removed by the heated water from the palagonite, are brought into contact with carbonic, hydrochloric, and sulphuric acids, they are converted into carbonates, sulphates, and chlorides, whilst the silicic acid remains dissolved in the alkaline carbonates formed, and in the water, and is partially separated from them by evaporation, as siliceous tuff.

The action of the carbonic acid is not, however, limited to the alkalies taken up by the water, but is directly extended to the substance of the palagonite, since it not only gives rise to a solution of silica in water, and alkaline carbonates, but induces also the formation of bicarbonates of lime and magnesia. The fact that only traces of the second of these earths are found in the water of the Geyser, may be easily explained from the circumstance that bicarbonate of lime is decomposed by ebullition into carbonic acid, and an insoluble neutral salt, or is decomposed in the same manner by the alkaline

Alkaline siliceous springs.

silicates, with formation of an alkaline carbonate. Traces of magnesia-salts, on the contrary, must be found in the water, in accordance with the result of analysis.

The products of hydrosulphuric acid upon palagonite experience a similar decomposition by carbonic acid. Sulphuretted hydrogen escapes as gas, whilst carbonate of lime, and to a certain extent carbonate of magnesia, are precipitated. The ultimate product of these reactions is again silicic acid, dissolved in water and alkaline carbonates, to which alkaline sulphides, as the constant accompaniment of these siliceous springs, are added, when the carbonic acid occurs in smaller quantity. The relation of the potassa to the soda in the water of the Geyser, is totally different from that which exists in palagonite. Experiment showed that soda is dissolved from palagonite by pure water, or by water saturated with carbonic acid, in a much larger proportion than potassa; and by carbonic acid even in a much greater quantity, than corresponds to the composition of the water of the Geyser. We may, therefore, readily understand that when the three volcanic gases are simultaneously acting, these alkalies may easily be dissolved to the relative extent in which they occur in the water of the Geyser.

Where the clinkstone and the older trap of Iceland break through the tuff, and still more, where the older trap penetrates in veins through the clinkstone, the penetrated rock exhibits a kind of fusion, frequently extending over a space of several feet, by which it assumes characteristics resembling those of obsidian, or pitch-stone. On tracing the horizontal strata which have been erupted from these veins, at their points of contact with the tuff, we soon lose sight of all appearance of fusion, or the action of fire. We are astonished to find that the main body of the tuff is composed of an easily fusible hydrated silicate, which has preserved its original character, and its normal proportion of water, notwithstanding its immediate contact with vast strata of trap, which have penetrated it in the fused condition. Still more singular are the innumerable vesicular cavities in the amygdaloid alternating with the tuff and trap, which are lined, and not unfrequently filled up, with quartz, chalcedony, calc-spar, zeolites, and other hydrated silicates.

Bunsen explains these facts by the phenomena of the still active fumeroles. Where the fluid trap came in contact with the surface of the vein, endowed with but a low cooling power, the water, present in the entire mass of the tuff, yielded, and was expelled by the action of the constantly renewed stream of fire; the rock was dehydrated and fused. On the other hand, where the fluid rock spread out

from these veins in far extended strata, and penetrated through the upheaved tuff; the farther development of the igneous action on the surrounding rock must have been arrested by the increased production of aqueous vapour, the great specific heat of the water, and the considerable latent heat of its vapour, making a greater elevation of temperature impossible in the tuff strata. The fumerole actions, which are owing to this vast evolution of aqueous vapour, must, therefore, necessarily be met again in the tuff and trap masses which served as a focus for their activity. And hence the amygdaloid, alternating with tuff and trap, which is so rich in hydrated silicates, present a faithful picture of the phenomena of decomposition, which are still found in full activity in the suffiones and boiling springs of Iceland.

Alkaline siliceous springs.

Formation of the Amygdaloid by Fumerole Action.—The amygdaloid rocks are the products of a metamorphosis of the original rock, which occurs at the point of contact between the trap and the tuff-strata. Their principal mass consists of a ferruginous, or siliceous clay, which occurs as a product of the still active fumeroles, and after passing through innumerable phases of decomposition, merges into the perfectly undecomposed strata of both these species of rocks. The penetration of aqueous and plutonic formations is to be ascribed to a great manifestation of fumerole activity, which has immediately followed the catastrophe of eruption; the original rock being converted into an aluminous amygdaloid, by a separation of its constituents, into soluble and insoluble silicates, in a manner analogous to what may still be observed. By these means, the plastic clay might easily be filled, through the agency of vapours and gases, with those innumerable vesicular cavities in which the products of crystallization of the soluble silicates, which penetrate the clay, are traced as complementary constituent parts. In a like manner, the occurrence of infusoria, the remains of which are found in the decomposing crust of volcanic rocks, may be explained, if we consider that the mass of such structures, converted by fumerole action into clay at its surface, and subsequently solidified by infiltration of soluble silicates, might easily contain within itself the conditions necessary for the life of the microscopic organisms, whose petrified remains are still found within these strata(1).

(1) Sartorius von Waltershausen (physisch-geographische Skizze von Island) endeavours to complete Bunsen's theory of the formation of zeolites in the Islandic amygdaloid, and of palagonite, by assuming that pressure exerts an essential influence upon chemical attraction. Since pressure is the *deus ex machina* of geologists—it was an

Theory of the Geysers.

Theory of the Geysers.—Bunsen(1) has proposed a theory of the Geysers, based upon very accurate thermometrical measurement, and altogether differing from the former explanations of this phenomena; this theory cannot be left unnoticed here, presenting as it does an interesting instance of the result obtained by an exact application of the principles of physics upon geological phenomena. A perfectly similar explanation has been subsequently given by Descloizeaux(2), who jointly with Bunsen had observed the temperatures at different depths of the Geyser-tube. Every silica-spring builds up a tube by the deposition of its siliceous sinter, and may, at a certain height become a geyser. If the tube be narrow at the upper end, and filled with a column of water, strongly heated below and rapidly rising, a continuous fountain is formed. The water at the mouth has a boiling-temperature corresponding to the pressure of the atmosphere; but when the spring has been surmounted by a tube, formed by gradual incrustations, it may easily attain at its base a temperature of upwards of 100^0, owing to the pressure of the fluid resting in the tube. The mass of water rising in such a spring, which is continually renewed from below, and possessing in the natural shaft of the spring, a temperature of 100^0, must immediately, on its escape from the mouth of the tube, experience a diminution of temperature, corresponding to the diminished pressure of the atmosphere, by which the whole excess of heat above 100^0 will be expended in the formation of vapour. The water raised by the expansive force of these vapours, and mixed with white foam, forces itself from the

object of interest to establish its effect by experiment. Wöhler, as is well known, had succeeded, by exposing apophyllite to the action of water, at a temperature of 180^0 or 190^0, under a pressure of from 10 to 12 atmospheres, in obtaining a solution of this mineral, from which, on cooling, it was deposited again in crystals. From this experiment, we cannot perceive whether the effect was due to the high pressure, or to the high temperature. By means of a simple apparatus, Bunsen (Ann. Ch. Pharm. LXV, 82) produced a measurable pressure of 110 atmospheres, which corresponds to a depth of more than 3000 feet in the sea. He found that the pressure, not only of 10 or 12, but even of 79 atmospheres, *without the co-operation of heat*, has not the slightest action upon pulverized apophyllite; in a like manner palagonite yields, even under a pressure of 103 atmospheres, only traces of soluble matter to water, whilst ebullition with water, under the pressure of 1 atmosphere, suffices to decompose it, and to dissolve appreciable quantities. Hence pressure alone cannot be considered as essentially affecting the play of chemical attraction.

(1) Extract of a letter addressed by R. Bunsen to Berzelius, Marburg, Nov. 1846; Ann. Ch. Pharm. LXII, 1; Pogg. Ann. LXXII, 159.

(2) Compt. Rend. XXIV, 456; Arch. Ph. Nat. IV, 83; Ann. Ch. Phys. [3] XIX, 471; Phil. Mag. [3] XXX, 391; Sill. Am. J. [2] III, 288.

Theory of the Geysers.

mouth of the spring, foaming and hissing in one continuous gush. On the other hand, when the geyser-tube is sufficiently wide towards its upper extremity to afford a considerable degree of cooling to the water, or when the column of water, considerably heated above 100°, passes slowly into the lower mouth of the tube, the water will suddenly burst forth into ebullition and eruption, whenever the fluid column, raised by some cause or other, f. i., by an accumulation of vapour in the depth, arrives at a pressure which no longer corresponds with its temperature. After these eruptive ebullitions, the temperature in the tube rises continually, the column when at rest, however, never reaches, not even a few minutes before the grand eruption, the boiling-point corresponding to the combined pressure of the atmosphere, and of the water at the height of observation. The elevation of the column of water which imparts the first impulse to the eruption, is induced by the peculiar property possessed by the Islandic thermal springs, of giving rise periodically, at certain points in the water of the thermal basins, to a number of large bubbles of vapour, which become suddenly condensed on rising into an upper and cooler stratum, where slight periodic detonations are occasioned, which precede the larger eruptions.

The periodic elevation of this mass of water, effected in the Geysers by this means, appears rarely to exceed 1 or 2 metres and is unable to upheave the water to an elevation, where it could burst forth into ebullition (owing to the deminished pressure existing there) until the *whole* mass has assumed a temperature at which it can begin to boil; such a temperature was actually observed by Bunsen, a few minutes before the eruption took place. From the preceding remarks, it is evident that the mechanical power has its principal seat in the water of the Geyser itself.

Unstratified Rocks. Formation of Granite.—The development of his doctrine of polymeric isomorphism, affords an opportunity to Scheerer(1) of bringing forward some observations respecting the formation of granite and its allied rocks, in which he participates in the objections, raised by Breislack(2), Fuchs(3), Boucheporn(4), and Schaafhäutl(5), against their plutonic origin. The chief argument is that the succession in which both the essential and accidental

(1) Bullet. Géolog. [2] IV, 468 ; Jahrb. Miner. 1847, 854.
(2) Traité sur la Structure du Globe, Paris, 1822, I, 356.
(3) Ueber die Theorieen der Erde, München, 1844.
(4) Etudes sur l'Histoire de la Terre.
(5) Münchener gelehrte Anz. 1845, 557.

Unstratified rocks. Formation of granite.

constituents of granitic rocks are proved, by their crystallization, to have solidified, does not agree with the fusibility of these substances; the difficultly fusible quartz being the medium of formation for the other constituents. Scheerer adduces, moreover, the fact that quartz is never found in lavas, although many veins of granite must have been cooled as fast as these lavas, and although some of the latter, at least some obsidians and pumice-stones, contain as much silica as granite itself.

The mechanical arrangement of the essential and accidental constituents of granite, showed that the crystallisation of achmite, garnet, gadolinite, tourmaline, amphibole, orthite, allanite, iron-pyrites, arsenical-pyrites and mica, has taken place before that of the felspar, and that the latter was separated before the quartz of the granite. In no case was quartz found to have interfered with the crystallisation of other minerals, whilst this was frequently observed to be the case with felspar. The author farther discusses the theory of "*surfusion*," imagined by Fournet in support of the plutonic theory. This theory supposes that liquid quartz, like sulphur, phosphorus, water, solidifies at a temperature lower than that at which the solid quartz is liquefied. In the case of water, however, the fusing-point and the point of solidification differ but a few degrees, and for sulphur too the difference does not exceed 100°. The fusing-point of silicic acid is about 2800°, whilst achmite, garnet, hornblende, tourmaline, iron-pyrites and other minerals occurring in granite, fuse between 1000° and 1500°, for it is well known that they all fuse with the greatest facility before the blow-pipe at about 2000°. According to Fournet's theory, the fusing-point of quartz would be from 1300° to 1800° higher than its point of solidification.

Scheerer is of opinion that the water (about 1 per cent) which is contained in some of the constituents of granite, was present before its solidification, and essentially co-operated toward its formation. On the other hand, granite has not been deposited from an aqueous solution, inasmuch as its constituents, by entering into its composition in the form of hydrates, would have introduced at least 50 per cent of water, and at the same time rendered the volume of the rock much more bulky. The heat of the plutonists has to be called in aid; it was heat which roused the chemical powers in the granite-paste, imparting to it the necessary plasticity; heat was an essential agent in the formation of granite, and its intervention explains a series of phenomena of contact, which are perceptible in the adjacent rocks. If we imagine this moist paste to be subjected to an increasing heat, under a pressure which prevents the evapora-

Unstratified rocks. Formation of granite.

tion of the water, it will probably be liquefied at a temperature far below that at which it would have fused in the anhydrous condition. If granite fused in this way, be cooled again, it evidently will give rise to phenomena, very different from those exhibited by the cooling of an anhydrous mass of otherwise similar constitution. We will observe that the temperature may be considerably diminished before the granite-paste loses its plasticity, a circumstance which is highly favourable to the crystallisation of its component minerals. The whole of the water not assimilated in the formation of these minerals, will be accumulated in, and re-absorbed by the residuary siliceous mass, which is thus kept in the liquid state for a considerable time, losing the water only when perfectly cool. In this manner, moreover, the pyrognomic properties of certain minerals may be preserved, which cease to be perceptible, if the minerals have been exposed to a very high temperature. (The term pyrognomic is intended to designate the property, possessed by certain minerals, of suddenly exhibiting, when heated to dull redness, a lively incandescence, according to H. Rose, attended with evolution of heat, and a change in some of the physical properties, without undergoing any chemical alteration, except perhaps a slight loss of water.) If these minerals had actually been in a state of igneous fusion, from which they passed to a white, and subsequently to a red heat, how is it possible to assume that they should still possess their pyrognomic properties? The exuding fluid holding in solution the remainder of the mineral constituents was absorbed by the masses of adjoining neptunic rocks, which were changed by the induction of phenomena of contact, by the conversion of clay-slate into gneiss and granitic rocks, &c.

The reading of Scheerer's memoir in the Geological Society of France, gave rise to some interesting remarks, especially of Delanoue, respecting the existence of water in certain bodies which have undergone igneous fusion. Some earlier experiments of Laurent were called to mind, who had observed that borate of potassa, when fused in a wind-furnace at a temperature exceeding the fusing-point of silver, still retained 1 per cent of water, from which it could be partly freed at a much lower temperature by softening the vitreous borate over the flame of a spirit-lamp(1).

Durocher(2) contests the views of Scheerer, and defends the origin of granitic rocks by igneous fusion. In his opinion, it was

(1) Bulletin Géologique [2] IV, 496.

(2) Bulletin Géolog. [2] IV, 1018; Compt. Rend. XXV, 208; Jahrb. Miner. 1848, 208, 337. Comp. also Compt. Rend. XX, 1275.

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not quartz which, remaining liquid all the time, was cooled to a temperature closely approaching the fusing-point of felspar; he thinks that it must have been a mineral similar to feld-stone, *i. e.* a substance somewhat less fusible than felspar, with which it agreed in most other respects. This mass contained silicic acid, alumina, alkaline, and earthy bases, potassa, soda, sometimes lithia, a portion of lime, magnesia, sesquioxides of iron, and manganese, together with small quantities of hydrofluoric, and frequently even of boracic acid. During the slow cooling of this mass, probably at a temperature of about 1500°, the constituents separated from each other in the form of felspar, quartz, and mica. In the moment of separation, when the temperature of the mass closely approached the fusing-point of the two most fusible components, *i. e.* of felspar and mica, the latter, having a greater tendency to crystallize, soldified more rapidly; and it may be presumed that the felspar in consequence of its greater faculty of crystallisation, has perhaps been solidified even before the quartz. According to Gaudin's experiments, silicic acid exhibits the deportment of a flux, remaining for a considerable time in a state of toughness, especially when surrounded by a mass which is itself very hot. During this process changes of temperature took place, chiefly in consequence of the play of two causes acting consecutively, and in an opposite direction. Before the constituents separated, silicic acid combining with other silicates, and thus inducing the formation of acid compounds, probably gave rise to the evolution of heat, while, on the other hand, the destruction of such a compound must have been attended with an absorption of heat. In the moment, then, in which the quartz was separated from a granitic combination, the slight depression of temperature which ensued naturally accelerated the solidification of such constituents as possessed the greatest tendency to crystallise. On the contrary, the heat disengaged immediately afterwards on the sudden solidification of the felspar was communicated to the surrounding medium, whereby the quartz was retained in a state soft enough to receive the impression of the felspar-crystals. The homogeneous mass separated into several definite compounds, remaining liquid in contact; in true granites the solidification of the several compounds took place in very short intervals, felspar, quartz, and mica, mutually obstructing their own elaboration; when felspar crystallised, quartz had been evidently separated from the mass.

Durocher adduces the results of his researches as unfavourable to Scheerer's assertions, that the crystallisations of the various constituents of granite, invariably exhibit the same succession. He is of

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opinion that the successive crystallisation of the constituents of granite from Hitteröe, in Norway, observed by Scheerer, must have been accidental; almost all the granites, examined by him, showed a simultaneous crystallisation; in many cases the quartz was partly solidified, when the felspar ceased to crystallise. Of the latter occurrence, he quotes a great number of instances. In a granite from Suc (Arriège), crystals of tourmaline or felspar are found in the middle of the quartz which has received their impressions; on the other hand, crystals of quartz are surrounded with a felspathic mass, and these different occurrences are perceptible even in the same specimen. Garnet, tourmaline, mica, and felspar, evidently solidified rapidly after each other, and the minerals which appear to have crystallised first, must have been still partly soft, when the others solidified. Hence a general character of granitic rocks would be the mutual penetration of their constituents, obstructing to a certain extent their own elaboration. In specimens in which the silicic acid has been accurately separated from the foliaceous, or crystallised silicates, and has crystallised last, Durocher assumes the co-operation of other forces, under the influence of which the silicic acid had been retained in the liquid state for a considerable period. This, however, does not apply to the ordinary granites.

The occurrence of iron-pyrites, arsenical-pyrites, and cobalt-glance, adduced by Scheerer as an argument against the igneous origin of granite, might be entirely exceptional; these minerals might be the result of subsequent formations, inasmuch as sulphides occur, in these places, also in rocks of a different origin. Magnetic and titanic iron too, have left impressions in felspar and quartz, frequently, however, they have been crushed by the crystallisation of the felspar. Zircon, corundum, polymignite, gadolinite and yttrotantalite, have likewise crystallised in the middle of felspathic masses, hence we have no right to believe that the least fusible constituents must have invariably crystallised after the others.

Nor is the fact that we observe no quartz separated from ordinary lavas, admitted by Durocher as an argument against the igneous formation of granite. Many trachytes, whose igneous origin is not contested, contain free silicic acid, frequently even in well-formed crystals, while also in other respects they are allied with granitic rocks by the presence of felspars, hornblende, and mica, and are connected with volcanic products through the medium of augite. In Italy we see trachyte pass over into granite, and trachyte-porphyry into quartz-porphyry.

As to the presence of pyrognomic minerals in granite, Durocher

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thinks that they by no means disprove the igneous origin of granite. He believes that these minerals, after having been calcined, had undergone a molecular alteration, such as we frequently observe in many substances (as for instance, in arsenious acid), when subjected to similar changes, reassuming after some time the original molecular arrangement.

Scheerer's most important objection, the presence of water in some of the constituents of granite, Durocher meets by asserting that the greatest amount of water is found in the accidental constituents of granite; a small quantity from 0·1 to 0·2 per cent was, however, found in most felspars; a perfectly transparent specimen of Fredericksvern, was alone proved to be absolutely anhydrous. Now, since felspar containing more than 0·2 per cent of water is invariably opaque, the presence of water might be attributed to incipient decomposition. Most granites, however, contain less than 1 per cent of water.

Durocher has examined a great many rocks as to the amount of water which they lose between 15^0 and 110^0; he found that most rocks of igneous origin, contain water which cannot be expelled, except by a dull red heat. In granite, feld-stone and quartz-porphyry exhibiting no trace of alteration, the amount of water present never exceeded 0·5 per cent; in granite this water is distributed among felspar and mica. The amount in slightly disintegrated specimens rises to 3, and even to 4·70 per cent, and is invariably the result of incipient kaolinisation; 1 or $1\frac{1}{2}$ per cent of water it would appear, may be absorbed without any trace of decomposition becoming perceptible. Melaphyre, basalt, lava, pumice-stone, contain more or less water, the amount in volcanic lava varies between 0·45 and 4·51 per cent. It is generally present in volcanic and pseudo-volcanic rocks, although trap is met with containing no water, which is wanting moreover in the basalt of Saint-Flour, and is reduced to a mere trace in obsidian. Hence Durocher considers the water to be chiefly of atmospheric origin, although he does not deny the existence of primary water in granite, lava, and trappean rocks.

Admitting, however, the presence of primary water in granite, Durocher does not conceive in what manner this water, as assumed by Scheerer, is capable of assisting in the liquefaction of the mass. The fusion of salts in their water of crystallisation, was the result both of their solubility in water, increasing with the elevation of the temperature, and of their affinity for this water, which enables them to retain it up to a temperature at which the salt may dissolve in it. To what extent, however, were quartz, felspar, mica,

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and hornblende soluble in water? What was the affinity of these substances for water? These minerals being neither soluble in, nor having any affinity for, water, Durocher thinks it rather bold to admit that the constituents of granite, in the presence of water, and when subjected to a strong pressure, should become liquid below their ordinary fusing-points. The water bursting forth during volcanic eruptions, never produced an effect upon the lava similar to that assumed by Scheerer for granite, on the contrary, such water only gave rise to vesicular cavities, which were never observed in granites of very crystalline texture.

The portions of quartz and mica in that variety of granite from Vire in Normandy, which is frequently used for the foot-pavements in Paris, Virlet d'Aoust(1) has taken for pebbles and adduced them as an argument in favour of the view, that granite had originally been a sedimentary formation. Durocher(2) is of opinion, that these portions are mere concretions.

Haidinger(3), although opposed to the doctrine of polymeric isomorphism, fully admits the importance of Scheerer's results for the history of the metamorphosis of minerals generally, if aspasiolite be considered as a pseudomorphosis of cordierite. Cordierite, as had been previously admitted by Scheerer, is the original formation produced, according to Haidinger, in such a position of the rocks, as is sufficiently deep and central to admit of a perfect separation of the water. At a later period, and in a higher position water was forced into the rock, and especially into the cordierite, which was thus deprived of its peculiar character. We have no measure of the depths at which changes of this kind may have taken place, nevertheless the period of cordierite may be considered as a standard of comparison for the history of granite, and of other crystallised rocks. When cordierite was separated in crystals, the fundamental mass frequently had not been converted into granite, at least not into that granite, in which cordierite has become pinite. Both the formation of pseudomorphs, and the changes of the rocks themselves, are the result of the continuous circulation of matter, and every specimen of our collections, according to Haidinger, affords a long history of its formation. For the rest, we refer to the comprehensive treatise

(1) Virlet d'Aoust [Bull. Géolog. [2] IV, 498; Jahrb. Miner. 1847, 861 (in abstr.)], believes granite as well as gneiss to be a metamorphic rock, formed from sedimentary deposits, and is of opinion that no primitive rocks exist on the surface of the earth.

(2) Bull. Géolog. [2] IV, 140.

(3) Haidinger's Abhandl. (Comp. II, 379), I, 79; Pogg. Ann. LXXI, 266; Jahrb. Miner. 1848, 218; Comp. II, 379.

Gneiss and gneiss-granite.

itself which contains moreover some excellent remarks respecting the formation of hydrated silicates in basalt, &c.

Gneiss and Gneiss-granite.—Naumann(1) contests the hypothesis that gneiss and similar rocks must invariably be altered sedimentary rocks, an opinion chiefly based upon their parallel texture and structure, and upon their frequent parallel connection with clay-slate, greywacke, and other sedimentary rocks. He arrives at the conclusion that in addition to metamorphic, and hypogenous, eruptive gneisses have to be assumed. He points out gneiss-like texture, and parallel structure in true volcanic and plutonic rocks, and adduces many instances, proving that the parallel structure of crystalline siliceous rocks, has been frequently the result of stretching or tension, to which the rocky masses of the whole district of eruption have been exposed before their ultimate solidification. Naumann distinguishes in the structure of these rocks a plane parallel texture, or flattening, and a linear parallel texture or stretching, the former being due to the action of pressing, the latter to that of stretching forces upon the masses.

Syenite.—Delesse(2) has examined the syenite of the Ballon d'Alsace. It consists of two felspars, namely orthoclase and another, closely agreeing with Abich's andesine, and a dark-green hornblende, for the description of which we refer to the mineralogical part of our Report(3). The following constituents were found not to be essential: quartz, sphene, mica, magnetic iron-ore, iron-pyrites, epidote, and ferruginous mica. The powdered syenite of Servance had a specific gravity of from 2·69 to 2·71, that of Them and Coravillers from 2·64 to 2·68. It varies within rather wide limits, increasing, *cæteris paribus*, with the amount of hornblende and andesine, and diminishing on the other hand with the quantity of quartz. The syenite in question, when ignited, loses 0·70 per cent, assuming a pale colour, and becoming friable; in a glass-oven it fuses to a glass strongly coloured with iron; the same fusion takes place in a black lead crucible, with reduction of iron and titanium. The quantities in which the various constituents are present, vary to a certain extent, the average composition being $\frac{1}{2}$ of orthoclase, $\frac{1}{4}$ of andesine, and $\frac{1}{4}$ of hornblende and quartz. The constituents had crystallised in

(1) Jahrb. Miner. 1847, 297; Quarterly Journal of the Geological Society of London, 1848, 1; Arch. Ph. Nat. VII, 322.

(2) Ann. des Mines [4] XIII, 667; Compt. Rend. XXV, 103; Arch. Ph. Nat. V, 332; with additions by the author, Jahrb. Miner. 1848, 769.

(3) Comp. II, 400, 408, 410.

Syenite.

the following order: first, orthoclase, and nearly at the same period hornblende; next, andesine, quartz filling the interstices and covering the acute edges of the crystals. Both hornblende and andesine, and even quartz are frequently in the middle of the crystals of orthoclase. The crystals of sphene, whose formation appears to have commenced with the beginning of the crystallisation, are found in other minerals, and even in orthoclase. The formation of the mica took place simultaneously with that of the hornblende, with which it is invariably associated. This order is by no means that of the fusibility of the constituents, a fact which has been noticed by other observers engaged in the examination of granitic rocks. According to the method communicated at the commencement of this part of our Report, Delesse(1) has determined the volumes of the constituents in several varieties (1, 2, and 3) of these syenites, and also the chemical composition of the rock, taken as a whole. In the following synopsis, *f* represents the buff variety, *b* the brown variety of orthoclase, *n* the white, and *r* the red variety of andesine, H hornblende, Q quartz, the numbers in brackets the specific gravities, A the percentage by volume, B the percentage by weight of the constituents.

1. (2·67)			2. (2·72)			3. (2·72)		
A		B	A		B	A		B
30	fb	29	24	b	23	20	f	19
32	r	31	30	r	29	34	b	33
10	H	12	21	H	24	16	H	19
28	Q	27	25	Q	24	30	Q	29

The percentage of each of the constituents is as follows:

	SiO_3	Al_2O_3	Fe_2O_3	CaO	MgO	KO	NaO	HO & residue.
1.	70·74	14·24	2·21	2·74	1·97	3·87	3·07	1·14
2.	67·49	13·28	3·98	3·95	3·74	3·55	2·73	1·28
3.	70·03	13·21	2·85	3·88	2·93	3·09	2·90	1·17

Porphyry. (Melaphyre.)—Delesse(2) has examined several porphyries (melaphyres) of the Vosges, and, for the sake of comparison, a few specimens from other countries. He arrives at the conclusion that the rocks of igneous origin, belonging to the same geological period, may frequently exhibit transitions into other rocks, differing from the former by their age, and by their chemical and mineralo-

(1) Comp. Vol. II, 454.

(2) J. Pr. Chem. XLIII, 417; XLV, 219; Bullet. Soc. Géolog. [2] IV, 774; Arch. Ph. Nat. V, 258, partially; Compt. Rend. XXV, 636; Jahrb. Miner. 1847, 846.

Porphyry, (Melaphyre.)

gical composition, that they may have undergone, moreover, partial changes which are, however, invariably local and accidental, and never affect the whole of the formation. He believes himself to be warranted in establishing the following principle: the rocks of the same age are generally of the same chemical, and mineralogical composition; and *vice versâ*, rocks of the same chemical composition, and formed by the same minerals combined in the same manner, are of the same age.

The rocks examined by Delesse, are the following: 1. Porphyry or melaphyre from Belfahy. The essential constituents of this rock, are a kind of labradorite-felspar and augite, for whose description we refer to the mineralogical part of our Report(1). The unessential components are, iron-pyrites, epidote, quartz, calc-spar, and a chlorite-like mineral, which is diffused in a fundamental mass of a dark-green colour, varying in many places from black to light-green and grey. The powder of the rock is generally of a light-grey. The structure is crystalline, the crystals are however microscopic. The specific gravity varies between 2·803 and 2·769. The fundamental mass almost invariably affects the magnet, the more so the darker its colour. The mass, like the felspar which it includes, contains water of constitution, the amount was found to be from 2·14 to 3·59 per cent. When ignited in contact with the atmosphere, these minerals assume a brownish-green reddish colour. The fundamental mass fuses before the blow-pipe with almost as much difficulty as felspar, a bottle-green bead being produced. With borax it forms a glass exhibiting the colour of iron, and dissolves completely in phosphorus-salt. On digesting, during two days, the fundamental mass with concentrated hydrochloric acid, 23 per cent were dissolved. Delesse analysed the following varieties: 1. Blackish-green fundamental mass of the porphyry of Belfahy. 2. Dark-green fundamental mass from the saw-mill near Puix. 3. Reddish fundamental mass of the porphyry of Giromagny.

	SiO	Al_2O_3	FeO_3	MnO	CaO	MgO	KO & NaO	HO
1.	53·17	19·77	8·56	0·51	3·87	4·96†	7·02	2·14
2.	50·79	27·25*	—	—	8·02		10·74†	3·50
3.	49·82	29·74*	—	—	7·31		10·93†	2·20

* With Fe_2O_3. † Calculated from the loss.

The rock completely fuses in a glass-oven, yielding a dense glass

(1) Vol. II, 410.

Porphyry. (Melaphyre.)

of conchoidal fracture, and strongly tinged with iron. After fusion it is perfectly decomposed by hydrochloric acid, granular silicic acid being separated. The analysis of the glass led to results which closely coincide with those obtained in the examination of the fundamental mass No. 1, proving that the average composition of the fundamental mass represents as nearly as possible the composition of the whole mass of porphyry. The microscopical examination of the fundamental mass exhibited, moreover, the presence of two minerals. Delesse calculated the amount of the constituents from the specific gravity, according to the formula:

$$D = \frac{MS + NF}{M + N}$$

D representing the specific gravity of the rock, S that of augite, F that of felspar, M and N the proportions by volume of augite and felspar in 1 vol. of the rock, so that $M + N = 1$. This calculation yielded from 65 to 70 per cent of felspar in the darkest varieties of the rock. The minerals composing the fundamental mass, are likewise labradorite-felspar, whose twin crystallization may be distinguished, and hornblende, the presence of which is inferred by Delesse from the deportment of the mass on calcination; for while in the varieties containing augite, the latter assumed a darkish colour, the fundamental mass was found to assume generally the light-brown or reddish colour which we are in the habit of observing in diorites, or in porphyries containing dioritic hornblende. This hornblende exhibits, however, a peculiar composition, inasmuch as it contains 53 per cent of silicic acid; moreover, it must evidently contain water and alumina, and lastly a quantity of lime smaller than that in felspar, whilst the ordinary hornblendes are usually rich in this earth.

2. *Spilite* of Faucogney (Haute Saône), a true amygdaloidal porphyry. The name *spilite* was given to this rock by Thirria. It is of a green, violet, or nearly black colour, of perfectly homogeneous appearance, of crystalline granular texture, and closely allied to the porphyry of Belfahy. The vesicular spaces are filled with carbonate of lime, enclosed in some ferruginous chlorite. The spec. grav. is = 2·906. It is magnetic. When viewed by the aid of a lens, it exhibits small greenish plates, with delicate striæ parallel to their longitudinal axes, an appearance which seems to indicate the twin crystals of labradorite. When heated before the blow-pipe the effect is similar to that produced on the fundamental mass of the rock of Belfahy, with which it is, moreover, closely allied in composition;

Porphyry. (Melaphyre.) containing, however, a larger quantity of the green silicate (hornblende), and scarcely 55 per cent of labradorite.

SiO_3.	Al_2O_3.	FeO*)	MnO.	CaO.	MgO.	NaO.	KO.	HO.	Total.
54·42	20·60	9·44	0·93	3·64	3·87	4·48	0·94	1·47	100·29

* Partly as Fe_2O_3.

3. Delesse has examined, moreover, the antique green porphyry which is closely allied with the porphyry of Belfahy. The felspar has the composition of labradorite, and is considered as such by the author. (G. Rose thought it was oligoclase). The spec. grav. of the fundamental mass of an olive-green variety was 2·915. The amount of water varied between 1·80 and 3·99, and was found to be greater in the green than in the violet varieties, the quantity increasing in the former with the beauty and the depth of colour.

SiO_3.	Al_2O_3.	FeO.	MnO.	CaO.	MgO NaO KO.	HO.
53·55	19·43	7·55	0·85	8·02	7·93*	2·67

* Calculated from the loss exhibited by the analysis with carbonate of soda.

4. Melaphyre from the Tyrol. The variety examined by Delesse had been collected between Bolzano and Colmar (?). The fundamental mass was of a light grey colour, with a tint of green, with small crystals of labradorite copiously diffused through the mass which, although agreeing in every other respect with the labradorite of the Vosges, may be distinguished by their grey colour and foliated appearance. The rock is magnetic, like all the melaphyres; it exhibits here and there small octahedrons of magnetic iron-ore. Although the melaphyres of the Tyrol and the Vosges are very analogous, the former are generally more vesicular and lighter, their mineralogical composition, too, appears to be more complicated, inasmuch as Delesse observed the presence of hypersthene and mica in several specimens; they contain, moreover, only half the amount of water (between 0·73 and 1·24 per cent), which has been found in the melaphyre of the Vosges.

5. Porphyry from Tyfholms Udden, near Christiana. These porphyries exhibit only partially the character of melaphyre. The fundamental mass is of a smoky grey, with a tint of reddish-brown. It principally contains labradorite, the twin crystals of which cross each other in every direction, but there are also crystals of the same mineral having a lighter colour, and not exhibiting twin crystallisation (comp. Vol. II, 410). The author mentions, moreover, a blackish lustrous silicate, containing what is usually believed to be hornblende (Cordier, Buch and Keilhau), and magnetic iron-ore, together with indistinct crystallised felspar-like portions. The spec.

grav. was found to be 2·771. The following is the mean of two analyses: Porphyry. (Melaphyre.)

SiO_3.	Al_2O_3.	FeO.	CaO.	MgO.	NaO KO.	HO.
55·29	18·78	9·46	3·14	3·48	8·68*	1·17

* Calculated from the loss.

The amount of silicic acid closely agrees with that of labradorite. Buch's acicular porphyry is a variety of the rock in question.

For the determination of the water, and the spec. grav. of the melaphyres of Norway, of the Ural and of Egypt, examined by Delesse, for the sake of comparison with the porphyry of Belfahy, we refer to the memoir itself.

Some of the facts brought forward by Delesse are of importance, inasmuch as they elucidate the close relation between melaphyre and basalt. The base of both rocks is the same, namely, labradorite; both contain, moreover, augite, magnetic iron-ore, and water. It is probable, that basaltic labradorite, like that occurring in melaphyre, contains water in chemical combination. As to the zeolites, it appears that they form no constituent of the fundamental mass, but are found only in the drusic cavities of the rock.

6. Porphyry of Ternuay, a rock which some consider as a variety of the labrador-porphyry of Belfahy, others as a transition porphyry, and diorite, which Cordier describes under the name of ophitone. The essential constituents of this porphyry are felspar and augite, the former being considered by the author as a peculiar species which he designates by the term vosgite, or felspar of the Vosges. For the description of both minerals, we refer to the mineralogical part of our Report(1). We remark only that both are hydrated, and that Delesse explains the presence of water in a plutonic rock by the pressure under which it was formed, and that in accordance with Scheerer's theory of polymeric isomorphism he believes this water to be basic. Accidental components of this porphyry are iron-pyrites and magnetic iron-ore; in some of the cavities are found, moreover, epidote (the pistacio-green variety), quartz, chalcedony, ferruginous chlorite, and a red foliated zeolite (probably heulandite), which is very liable to disintegration. Here and there the fundamental mass is penetrated by mica, but only in such parts as appear to have been altered under the influence of adjacent rocks; at the borders of the rock traces of diallage, and of the various felspars, as well as of oligoclase and andesine, are

(1) Vol. II, 400, 410.

Porphyry. (Melaphyre.)

observed. Characteristic specimens of this porphyry consist, however, entirely of vosgite and augite. Many parts of the rock, in which the crystals are microscopic, are of a uniform green colour, and exhibit only a few isolated, large, and well-formed crystals of augite. The spec. grav. varies between 2·857 and 2·833; that of the darker varieties was found to be 2·885. Eight varieties exhibited on ignition the following loss: 3·02, 3·17, 3·25, 3·41, 3·45, 3·50, 3·57, 4·06 per cent. Under the influence of heat it assumes a light reddish-brown colour, the structure becoming at the same time more perceptible. When heated in a glass-oven, it yields a brownish-black, radiated, perfectly crystalline mass, whilst, by fusion in a black-lead crucible, only a bottle-green glass is obtained. By comparing the density and the proportion by volume of vosgite in the volume-unit of the rock, Delesse ascertained that the porphyry of Ternuay contains from 75 to 80 per cent of its volume or weight of this mineral. These determinations may be controlled by the estimation of the water, or of the lime, &c., in given quantities of the rock, and of its two constituents; experiments of this kind confirmed the above data, and led to the following composition of the porphyry, when viewed as a whole:

	SiO_3.	Al_2O_3.	Fe_2O_3.	MnO.	MgO.	CaO.	NaO.	KO.	HO.	Total.
1. 26 Augite:	12·7	1·3	1·9	—	4·2	4·9	—	—	0·6	99·3
74 Vosgite:	36·5	22·3	0·5	0·4	1·5	3·2	3·6	3·3	2·4	
2. 19 Augite:	9·3	1·0	1·4	—	3·0	3·6	—	—	0·4	99·4
81 Vosgite:	39·9	24·4	0·6	0·5	1·6	3·5	3·9	3·7	2·6	

Transition-Slate.—In addition to the above, four specimens of transition-slate, taken from the neighbourhood of porphyry, have been examined by Delesse. He found that the amount of water and silicic acid increases in the same proportion as the rock assumes more and more the character of slate, while the quantity of lime diminishes at the same rate.

	Spec. grav.	SiO_3.	Al_2O_3. Fe_2O_3. MgO.	CaO.	NaO and KO.	HO.
1.	2·852	52·7	34·0	2·4	7·5*	3·4
2.	2·764	60·8	29·6	0·5	4·2*	4·9
3.	2·752	62·7	26·0	0·8	6·0*	4·5
4. †	2·743	60·0	30·0	0·5	4·2*	5·0

* With MgO. † Taken at a distance of three metres from the first specimen.

Protogyne.—Delesse(1) has communicated to the French Academy an analysis of protogyne which he considers to be metamorphic,

(1) Ann. Ch. Phys. [3] XXV, 114; Bullet. Soc. Géolog. [2] VI, 230; Instit. 1848, 287; Compt. Rend. XXVI, 306; Arch. Ph. Nat. X, 240; Phil. Mag. [3] XXXIV, 233; Jahrb. Miner. 1849, 360.

Protogyne.

chiefly on account of the transition into stratified rocks which it exhibits. The chief constituents are quartz, orthoclase, oligoclase, binaxial mica rich in iron, and a variety of talc. It is distinguished from granite by the presence of talc which is rarely found in the latter rock. Both the mineralogical and chemical composition is subject to slight variations. A specimen of the protogyne of Mont Blanc yielded on analysis the following results: silicic acid 74·25, alumina 11·58, sesquioxide of iron 2·41, sesquioxide of manganese traces, lime 1·08, magnesia, potassa, and soda 10·01, water 0·67.

Trachyte.—Morlot(1) has analysed the trachyte of the Gleichenberg, which he assimilates to Abich's trachydolerite(2), and for which he also proposes the latter name. It is a dense rock of a greyish-green colour, resembling feld-stone porphyry. It exhibits the planes of cleavage of very small crystals of felspar, which are otherwise not perceptible.

Spec. grav.	SiO_3.	Al_2O_3.	FeO.	MnO.	MgO.	CaO.	KO.	NaO.	HO.
2·64	57·17	16·90	8·50	trace	1·90	6·30	3·90	1·00	3·38

On comparing these data with the results obtained in the analysis of the mineral water of Gleichenberg, we find the same constituents, and considering their relative solubility, even the same proportionate quantities; with the one exception, that in the analysis of the latter the whole of the alkalies is given as soda. The analyses of phonolite, by Gmelin and Struve, have proved that disintegrated rocks are frequently richer in potassa than the rocks in a state of preservation, the larger amount of soda being carried off by the atmospheric water. In consequence of these observations, Morlot considers himself justified in assuming that a similar change has taken place in the case in question. He believes, however, that in the depth of the earth a metamorphosis took place, in which potassa-felspar was formed, inasmuch as granites frequently exhibit orthoclase as a pseudomorphosis of albite. Morlot thinks that the amorphous lava of the Gleichenberg, when in a state of igneous fusion, may have given rise to the formation, at the surface of the earth, of trachyte and phonolite; in the interior, of porphyry or even of granite; he adds, however, that this is rather a theoretical speculation which requires farther experimental inquiries.

(1) Haidinger's Berichte (comp. Vol. II, 379) II, 236. 336.
(2) Pogg. Ann. LXVI, 109; LXVIII, 476.

Diorite.

Diorite.—Delesse(1) has examined the spherical diorite of Corsica. For the description of the felspar, which is remarkable for its being a monosilicate, and closely allied to anorthite, and of the hornblende occurring in this rock, we refer to the mineralogical part of this Report(2). These two minerals form alternate concentric layers, the interior exhibiting frequently a granitic composition. The development of these spheres has taken place in a dioritic fundamental mass sometimes of a middling, sometimes of a coarser grain. They contain, moreover, mica of a green colour, iron-pyrites, formed after the hornblende, of which it shows impressions, magnetic iron-ore and quartz, the latter being a rather remarkable occurrence in a rock containing a felspar so poor in silicic acid. Delicate veins of epidote and ripidolite are likewise frequently perceptible. The spec. grav. is 2·768, which would indicate that felspar and hornblende are present in the ratio of 90 : 10. A special experiment gave 48·05 per cent of silicic acid, and 11·04 of lime, from which results 80 per cent of felspar and 20 per cent of hornblende.

Arkose.—Delesse(3) gives a description of the felspathic sandstone of Poivin in the Vosges, which has been termed arkose. He believes this rock to be a sedimentary sandstone metamorphosed in the moist way by the assimilation of hyalite and felspar. Below it forms a gradual transition to the granite on which it rests, whilst the top portion changes to the ordinary sandstone of the Vosges. The chief constituents of the arkose, which frequently exhibits the structure of porphyry, are hyalite and orthoclase, the latter often regularly crystallised with the longitudinal axis of the crystals perpendicular to the direction of the strata(4). The felspar thus newly formed, exhibits no trace of decomposition; whilst the fragments of granite occurring in arkose are nearly perfectly decomposed, and converted into kaoline and hydrated silicate of magnesia. Unjustly this rock has been regarded as an eruptive porphyry, as it not only contains rolled pebbles, but also stratiform clay, which, at no great distance from the granite, exhibits impressions of plants. These clays are rich in silicic acid, hard, soniferous, and very dense; they have

(1) Ann. Ch. Phys. [3] XXIV, 435; Compt. Rend. XXVII, 412; Instit. 1848, 325; Jahrb. Miner. 1848, 661.

(2) Vol. II, 400 and 410.

(3) Arch. Ph. Nat. VII, 177.

(4) For information respecting the felspar imbedded like porphyry, we refer to Vol. II, 408, of our Report.

a slaty texture, and a striped appearance. The quantity of water present in these clays amounts to 2 per cent, which is very inferior to that found in ordinary clays. The rock is penetrated, moreover, by veins of quartz, specular-iron, heavy-spar, fluor-spar and chalcedony, all of which occur likewise in the fundamental mass. The pebbles of the sandstone, consisting chiefly of granite, quartz, siliceous slate, &c., gradually change into a chalcedonic or hornstone-like base, which is frequently observed to assume a stratified structure. According to Delesse the felspar-crystals have been formed in the moist way, after the deposit of the sandstone, silicic acid being assimilated, which was derived from hot springs. Arkose.

Gabbro.—G. Rose(1) observed stratified gabbro, occurring between serpentine and granite, and resting upon the latter, at the Zobtenberg, in Silesia. In some parts it changes into a green slate, at others into serpentine. Rose concludes from these observations, that gabbro, and perhaps also serpentine, are altered rocks, produced by the influence of granite upon earlier sedimentary formations.

According to Burat(2) constant relations are observed to exist between trappean rocks, and the veins of ore which occur along with them. Under the term trappean rocks, Burat comprehends all silicates of the bases isomorphous with magnesia, of lime, of protoxide of iron, &c., such as greenstone, hornblende, amygdaloids, spilite, variolite, euphotide, and serpentine. The author has pointed out this relation in detail for the serpentine of Tuscany, and the gabbro, for the greenstone and *Schalstein* of Nassau, for the *Blatterstein* of the Hartz, and for the copper-ores of Cuba, and of Lake Superior in Canada. He believes the serpentine of Tuscany to be an eruptive rock, and the gabbro to be a product of contact, and distinguishes a green and a red variety of the latter rock. The green variety forms a kind of transition between serpentine, and red gabbro and the decidedly stratified rocks called Galestri and Mattoni. The green variety of gabbro contains steatite, like the serpentines with which it is sometimes associated; it changes to the red variety by becoming spotted in the first place, and then assuming a uniform colour by the assimilation of sesquioxide of iron. The copper- and iron-ores are either imbedded in these contact-rocks, or disseminated in eruptive hornblende-rocks which are combined with serpentines. Veins of steatite frequently separate green and red gabbro from masses of serpentine, and shoot some-

(1) Bullet. Soc. Géolog. [2] IV, 1061. (2) Ann. des Mines [4] XIII, 351.

Gabbro. times through gabbro in parallel layers, exhibiting curved surfaces of contact which indicate the stratification of the rock. These veins Burat believes to have penetrated into the rock immediately after the eruption of the serpentine.

According to Burat, specular-iron, as well as the other ores occurring in gabbro, or in stratified formations in the vicinity of serpentine, are the results of metallic emanations from the interior. Of this origin are the ores in the vicinity of Dillenburg, &c. The *Schalstein* of Nassau, the *Blatterstein* of the Hartz, and the gabbro of Italy—all derived from trappean rocks under the influence of metamorphic actions—exhibit an additional common character, namely, the intensely red colour, and the massive separation of sesquioxide of iron. In the normal condition these rocks are green, evincing more or less the character of trap, and forming a link of transition between eruptive rocks and elevated stratified rocks. The amount of protoxide of iron which they contain in this normal condition precludes the assumption that the change is merely dependent upon a higher oxidation of the iron present; the amount of iron has been increased to such an extent that these rocks become closely allied to the accumulated masses of pure sesquioxide of iron. The same quantity of iron is found in the red clay-state of Dillenburg, in the red flinty-slate of the Hartz, in the galestri and in the red jasper of Tuscany; all these rocks have been formed by emanations of sesquioxide of iron following the eruption of the trap, and correspond in this respect with the products of the solfataras, and with the formation of specular-iron in the volcanoes of the present epoch.

The variegated sandstone, the sandstone of the Vosges, the variegated marl, in general, the gypseous and saliferous marls of the secondary period, all exhibit this colouring by anhydrous sesquioxide of iron, which has been accumulated in these formations to a very considerable extent. From these observations, Burat infers that the interior of the earth during the whole of the geological period must have been a focus of continuous emanations, carrying enormous quantities of sesquioxide of iron to the surface, the anhydrous product being either mixed with the sediment, or inserted in the form of concentrated layers between the sedimentary rocks elevated by the trap.

Lavas.—Genth(1) has examined various lavas from Hecla, brought home by Bunsen.

(1) Ann. Ch. Pharm. LXVI, 13; Arch. Ph. Nat. IX, 72.

	SiO_3.	Al_2O_3.	FeO.	MgO.	CaO.	NaO.	KO.	MnO CoO NiO.	Total.	Lavas.
1. Thjorsá lava (an old current) .	49·60	16·89	11·92	7·56	13·07	1·24	0·20	traces	100·48	
2. Lava of Háls (more recent) .	55·92	15·08	15·18	4·21	6·54	2·51	0·95	trace	100·39	
3. Lava of Efrahvolshraun (still more recent) . .	60·06	16·59	11·37	2·40	5·56	3·60	1·45	trace	101·03	
4. Lava of 1845 . .	56·68	14·93	13·93	4·10	6·41	3·46	1·07	trace	100·58	
5. Ash of the eruption of 1845. .	56·89	14·18	13·35	4·05	6·23	2·35	2·64	0·54	100·23	

Taken from a pure snow-field.

1. Greenish-black fundamental mass, with vesicles partly filled with the two other constituents, thjorsauite, a new mineral, and chrysolite, partly empty and lined with small rhombic crystals. The fundamental mass amounts to about $\frac{2}{3}$ of the whole lava; but is so intimately intermixed with the other constituents, that it cannot be obtained in a state of purity. The ratio, in which the constituents of this lava are combined, may be represented by the formula $5\ (3\ RO,\ 2\ SiO_3) + (4\ Al_2O_3,\ 3\ SiO_3)$. For the description of the thjorsauite and chrysolite we refer to the mineralogical part of this Report(1).

2. Crystalline; the system of crystallisation, however, not determined, probably rhombic, of uneven fracture, opaque, greyish-black, the planes of crystallisation and of cleavage exhibiting a dull glassy lustre. Yields a grey powder. Spec. grav. at $5^0 = 2{\cdot}919$. Hardness from 5·5 to 6. Slightly magnetic. Small bits, when heated before the blow-pipe, fuse into black glassy beads; it shows, when treated with borax or phosphorus-salt, the reaction of iron. Insoluble in hydrochloric acid. Compact, of a fine grain, filled with vesicles, in which rhombic crystals are perceptible. Sparingly penetrated by a white crystalline foliated mineral (thjorsauite?), and slaggy magnetic iron-ore. Genth assumes the formula $(3\ RO,\ 2\ SiO_3) + (Al_2O_3,\ 2\ SiO_3)$. The result of this analysis coincides with the composition of Laurent's wichthyne (wichtisite, of Hausmann).

3. Non-crystalline; fracture uneven, somewhat conchoidal; lustre

(1) II, 401 and 407.

Lavas. dull; colour black, inclining to grey; powder grey. Spec. grav. at $5^0 = 2{\cdot}776$; hardness = 5·5 to 6. Slightly magnetic. The mass appears to be nearly compact, but contains a great many small vesicles, having rarely the size of millet-seed. The lava contains from 2 to 3 per cent of a white, felspar-like, crystalline, foliaceous mineral (orthoclase ?). It also contains, but in still smaller quantity, chrysolite and slaggy magnetic iron. The ratio of the constituents is approximatively represented by the formula $(3\ RO, 2\ SiO_3) + (Al_2\ O_3, 3\ SiO_3)$.

4. Crystalline; fracture uneven, somewhat conchoidal; colour black, inclining towards grey; lustre slightly vitreous, on the small crystalline planes somewhat metallic. Powder grey. Spec. grav. at $5^0 = 2{\cdot}819$. Hardness from 5·5 to 6·5. Slightly magnetic. Before the blow-pipe, and with hydrochloric acid, it exhibits a deportment similar to that of the preceding specimens. Partly compact, partly vesicular, the vesicular spaces lined with small crystalline faces. This lava, like that of Efrahvolshraun, contains a felspar-like mineral (perhaps the same), although in inferior quantity, and in smaller crystals. The composition of the lava may be represented by the formula $(3\ RO, 2\ SiO_3) + (Al_2O_3, 2\ SiO_3)$.

5. Small slag-like particles, sometimes of the size of a small pea, sometimes in the form of dust; lustre slightly vitreous; sometimes the lava has a dull appearance. Colour blackish-grey, in many places red.

The lavas from Hecla differ from those of Vesuvius and Etna, as well as from most basalts and phonolites, by not containing a constituent which, when extracted by hydrochloric acid, will gelatinise; in fact, they are insoluble in hydrochloric acid, with the exception of traces of magnetic iron-ore. They all contain an essential constituent of the same composition as wichtisite, and if the elements are not present in the proportion of wichtisite, we find other minerals separated in or beside the latter, such as thjorsauite, chrysolite, orthoclase(?), magnetic iron-ore, &c.

Stratified Rocks.—By his analyses of haydenite, of steatite and talc, Delesse(1) has arrived at the conclusion that talc-rocks have not actually a plutonic origin. He is of opinion that talc- and steatite-slate, gneiss, protogyne, and all analogous rocks are of a mixed origin, being formed in the moist way, and subsequently altered by igneous action.

(1) Ann. des Mines [4] XIII, 235; Arch. Ph. Nat. IV, 85.

Serpentine-slate.

Serpentine-slate.—Delesse(1) has examined slate of Villa Rota on the Po, which has a greenish-grey colour, and nacreous lustre. It occurs in thin leaves, translucent, easy to cut and pulverize, unctuous to the touch, and of a spec. grav. = 2·644. When calcined it assumed a greyish-brown colour; thin splinters fused before the blow-pipe, but only with difficulty, becoming a whitish-grey glass. In phosphorus-salt it left a very minute skeleton of silicic acid; with cobalt-solution it assumed a lilac colour, and was readily attacked by acids, pulverulent silicic acid remaining behind. As the mean of two analyses the following numbers were obtained: silicic acid 41·34, alumina 3·22, protoxide of iron 5·54, magnesia 37·61, water 12·06, together with oxide of chromium and protoxide of manganese. Delesse adduces the formula $3\,R_2\,O_3, SiO_3$. From these physical properties this slate might be called talc-slate or chlorite-slate, analysis, however, brings it nearer to serpentine. Delesse considers it as serpentine-slate, and classes it with the marmolite of Vanuxem, and several slates from the Alps analysed by Schweitzer.

Dolomite, and its Formation.—Fournet(2) has given a history of dolomite, both as a mineral species and as a rock, for which we refer to the original memoir.

Monheim(3) has examined dolomite from the boundary of the calamine-mine at the Altenberg. It was found to contain:

SiO_3.	CaO, CO_2.	MgO, CO_2.	ZnO, CO_2.	FeO, CO_2.	MnO, CO_2.
0·48	54·31	43·26	1·38	0·99	0·56

Morlot(4) has investigated a sandy dolomitic rock, from the Hausberg, near Stübing. Stratified, slaty, slightly yellowish-red mass, of earthy fracture, easily scratched, effervescing with acids. Analysis yielded:

Spec. grav.	CaO.	MgO.	$Al_2\,O_3$.	$Fe_2\,O_3$.	$HO\,CO_2$.	Residue insoluble in HCl.
2·69	13·8	6·6	2·2	1·6	20·7	55·0

The residue contained 61·5 per cent of silicic acid, 23·4 of alumina, 3·4 of sesquioxide of iron, 8·2 of potassa, and 3·5 of soda. The whole, therefore, consisted of 45 per cent of an impure dolomite, and 55 per cent of a felspathic sand.

(1) Ann. des Mines [4] XIV, 79; Arch. Ph. Nat. VIII, 111; Jahrb. Miner. 1848, 658.

(2) Ann. de la Soc. Roy. d'Agricult. de Lyon, 1847; Arch. Ph. Nat. VI, 240; Jahrb. Miner. 1848, 102.

(3) Verhandl. des Naturhist. Vereins der Preuss. Rheinl. 1848, 41; Jahrb. Miner. 1848, 826.

(4) Haidinger's Berichte (comp. II, p. 379) II, 242.

Dolomite, and formation of dolomite.

Morlot(1) gives a theory of the formation of dolomite, which he has endeavoured to support by experiment. At an earlier period Haidinger had been led, by the frequent association of dolomite and gypsum, to suppose that the origin of this rock was owing to the action of sulphate of magnesia upon limestone, whereby sulphate of lime is produced, the molecular change being facilitated by the different solubility in water of the substances produced. A solution accordingly of sulphate of magnesia should convert the carbonate of lime into the double salt of dolomite, with simultaneous separation of gypsum. Since, however, experiment proves that a solution of gypsum, filtering through pulverized dolomite, converts the latter into pure carbonate of lime with formation of sulphate of magnesia, he supposed that the reaction might be reversed in the depths of the earth at a higher temperature, and under the influence of a correspondingly increased pressure. Haidinger thought, although at the common temperature gypsum converts dolomite into limestone and sulphate of magnesia—(he adduces the efflorescence of the latter salt observed by him in a quarry of gypsum)—that at a high temperature and under increased pressure, the magnesian sulphate might be capable of converting calc-spar into dolomite and gypsum. The temperature at which this reversion of the affinities might take place, had been estimated by Haidinger as 200^0 at the most, corresponding to a pressure of 15 atmospheres. Now Morlot has proved, by experiment, that a mixture of crystallised sulphate of magnesia and pulverised calcareous-spar, when exposed in the proportion of 1 to 2 equivalents, in sealed tubes, to the temperature and pressure mentioned, are so completely converted into a double salt of carbonate of lime and carbonate of magnesia on the one hand, and sulphate of lime on the other, that not a trace of sulphate of magnesia remains behind.

Elie de Beaumont(2) had calculated that in a measured space the replacement of a double atom of limestone by 1 atom of dolomite, should give rise to the formation of a certain number of drusic cavities, 12 per cent of the whole volume, owing to the higher spec. grav. of the whole, and the lower equivalent of magnesia. In the examination of a dolomite from Prediel, Morlot found 12·9 per cent of such cavities, which closely agrees with theory.

(1) Haiding. Berichte (comp. II, 379) II, 393. 461 and IV, 185; Pogg. Ann. LXXIV, 591; Jahrb. Miner. 1847, 862 and 1848, 489.

(2) Compt. Rend. XXVI, 311; Sill. Am. J. [2] VI, 268; Bull. Géolog. [2] V, 243; Arch. Ph. Nat. VII, 324; comp. also Bull. Géolog. 1837, 174.

Dolomite, and formation of dolomite.

Incidentally to the above doctrine of the formation of dolomite, Dana(1) remarked that many compact limestones of America, containing from 30 to 40 per cent of carbonate of magnesia, exhibit no signs of the action of fire. An analysis of fresh corals by Silliman, Jun., yielded less than 1 per cent of magnesia; on the other hand, in compact coralline limestone, which evidently had not been exposed to igneous action, 38·07 per cent of carbonate of magnesia were found. Another rock, consisting of the *débris* of corals, contained 5·29 per cent. These observations seem to indicate the possibility, under peculiar circumstances, of a reaction between the magnesia-salt of the ocean, and the carbonate of lime of the corals, at the temperature of the water in tropical climates. This action would favour the solidification of the rock which is in progress at the bottom of the sea.(2)

Frapolli(3) has communicated to the Berlin Academy researches on the geological occurrence of gypsum, dolomite, and rock-salt, in the neighbourhood of the Hartz. His ideas respecting the formation of these rocks are so improbable, that we must pass them over.

Sandberger(4) has been led by his researches on the dolomites of Nassau, to adopt the view proposed at an earlier period by Grandjean(5). According to this theory, dolomite has gradually originated from a black limestone, rich in magnesia, decomposed by the influence of carbonated water, the product being, together with dolomite, bicarbonate of lime which, in the crevices of the rock, is deposited in the form of calcareous sinter, and calcareous spar. The metallic oxides, frequently present in considerable quantity in the original rock, are precipitated, their constant occurrence in dolomite being thus easily intelligible. Sandberger is, however, unwilling to apply this view to all dolomites, until we are in possession of additional investigations.

(1) Sill. Am. J. [2] VI, 268.

(2) A fresh-water limestone, of the brown-coal formation, near the village of Rœdgen, in the neighbourhood of Giessen, contains a very large amount of magnesia. Two analyses by Knapp gave the following composition:

	CaO, CO_2.	MgO, CO_2.	Fe_2O_3.	Insoluble.
1.	42·80	49·63	1·65	1·42
2.	46·42	38·03	1·39	11·21

(3) Pogg. Ann. LXIX, 481; Bull. Soc. Géolog. [2] IV, 832; Jahrb. Miner. 1847, 609; 1848, 629.

(4) Uebersicht der Geol. Verhältnisse des Herzogth. Nassau, Wiesbaden, 1847.

(5) On Dolomites in the Lahn-Valley, Jahrb. Miner. 1844, 543.

Dolomite, and formation of dolomite.

(All observations, and especially the fact of the conversion of limestone into dolomite, being almost limited to the upper strata, and to the vicinity of clefts, are in favour of a pseudomorphic formation from limestone, rich in magnesia. It deserves to be noticed, that both carbonate of lime, and carbonate of magnesia alone, are much more soluble than the dolomitic double compound produced by their combination.)

Nauck(1) has investigated the well-known steatites of Göpfersgrün, and believes that these as well as the dolomites occurring in that place are pseudomorphs, formed in the moist way. The silicates present were decomposed by carbonated water which conveyed the dissolved substances, especially magnesia and silicic acid, to other localities, where they were deposited. By water, containing carbonate of magnesia, the so-called primitive lime was converted into dolomite, whilst the presence of silicic acid in the water gave rise to the formation, in the clefts and crevices, of crystals of quartz; if the water contained silicate of alumina, the rocks were converted into steatite. This theory admits a variation in the mineral constituents of the water. But we may assume also that a solution of silicate of magnesia in atmospheric waters when percolating through strata of lime, dissolves carbonate of lime, and that the magnesia, owing to its tendency to form double compounds, parts with its silicic acid, and combines with the bicarbonate of lime dissolved in the water, giving rise to the formation of a dolomitic double compound. The liberated silicic acid is deposited in the drusic cavities of the dolomite, in the form of quartz, or opal. The formation of dolomite and quartz will continue until the silicate of magnesia ceases to find carbonate of lime. If this point be reached, the silicate of magnesia is itself deposited in the form of steatite, and may lastly convert dolomite and crystals of quartz into the same mineral.

Fossiliferous Lime.—Schnabel(2) has analysed the Muschelkalk of Saarbrücken. It contains:

CaO.	MgO.	SiO_3.	Al_2O_3.	Fe_2O_3.	HO.	CO_2.	Org. subst.	Loss.
53·09	0·46	2·62	0·44	0·86	0·32	41·93	trace	0·28

Marchand(3) has examined the rock of the Mount of Olives, near Jerusalem, which consists of a yellowish-white, crumbling, porous limestone. It contained hygroscopic moisture 0·319, water in chemical combination 0·488, chloride of calcium 0·400, sili-

(1) Pogg. Ann. LXXV, 129.
(2) Verhandlungen des Naturhist. Vereins der Preuss. Rheinl. 1848, 150.
(3) J. Pr. Chem. XL, 192; Jahrb. Miner. 1846, 706.

cates 0·075, carbonate of lime 98·718, iron, magnesia, and alumina traces.

Rock-salt, gypsum, anhydrite.

Rock-salt, Gypsum, Anhydrite.—Karsten(1) is of opinion that rock-salt and anhydrite burst forth from the interior of the earth, and were subsequently transformed. Gypsum he believes to originate from anhydrite, either in the places where it had originally been deposited, or after it changed its locality. According to Karsten, dolomite is "a limestone of any period of formation, changed by cementation with the vapour of magnesium." The generation of dolomite in the moist way, or from limestone in a state of igneous fusion, appears to him impossible.

Pseudomorphs, imitative of Rock-salt.—Haidinger(2) has published an elaborate treatise regarding the pseudomorphs imitative of the cubes of rock-salt, exhibited by quartz, dolomite, gypsum, compact limestone, &c., from almost all the geological formations. He gives, moreover, an explanation of the cubic crystallisation of the sandstone from Stuttgart, which agrees with that of Nöggerath. Gutberlet(3) has described the occurrence of these cubes in the variegated marls and sandstones in the neighbourhood of Fulda; they have been also observed by Hausmann(4), in the fossiliferous limestone of Hehlen.

Boracite, in the amorphous State, has been found at a depth of 797 feet, in variegated sandstone, by Karsten(5), when he sank a shaft for rock-salt, in the neighbourhood of Stassfurth. We refer to our Mineralogical Report for farther details respecting this discovery, which is of great interest for the theory of the exhalation of boracic acid in Tuscany, and of the borax-lakes in Tibet.

Formation of Coal.—By a series of investigations respecting the coal deposits in the interior of Germany, Göppert(6) has proved

(1) Karsten's Archiv. 1848, 545; Berl. Acad. Ber. 1848, 129; Jahrb. Miner. 1848, 596; Instit. 1848, 367.

(2) Haidinger's Abhandl. (comp. II, 379) I, 65; Haid. Berichte II, 13, 61; Pogg. Ann. LXXI, 247.

(3) Jahrb. Miner. 1847, 405, 513.

(4) Archiv. für Miner. u. Geogn. XXI, 494.

(5) Berl. Acad. Ber. 1847, 14; J. Pr. Chem. XLII, 310; Arch. Ph. Nat. VI, 66; Pogg. Ann. LXX, 557; Jahrb. Miner. 1848, 336; Jameson's Edinb. Journ. XLV, 180; Sill. Am. J. [2] IV, 415.

(6) Pogg. Ann. LXXII, 174; Naturkund. Verhandel. van de Holl. Maatsch. der Wetensch. te Haarlem, 1848; Abhandlung als Antwort auf die Preisfrage - - - von Göppert. Gekrönte Preisschrift. Leiden und Düsseldorf, 1848; Jahrb. Miner. 1847, 109 and 1848, 726; from Verhandl. der schles. Gesellsch. für vaterl. Cultur, in J. Pr. Chem. XLII, 56; Arch. Ph Nat. VII, 320; Instit. 1848, 74; Brit. Associat. Reports, Oxford, 1847; Haidinger's Berichte (comp. II, 379) III, 116.

Formation of coal.

that coal has been produced in the moist way, exactly as the turf of the present time, the formation of which still proceeds under our eyes. The various plants of the respective localities, which were converted into coal, may be traced in the slaty clays, &c., accompanying the coal-seams, and can still be distinguished in the coal by their more or less fine structure. The trees are for the most part crushed, so as to become flattened in the direction of their diameters; they are usually without parenchym; in some cases, however, even this is converted into coal, and then mere friction of the masses enables us to distinguish the cells of the parenchym, by means of the microscope.

Fibrous Coal.—Göppert has a peculiar view respecting the formation of the so-called mineral wood-charcoal, or fibrous coal: he believes that it is derived from the wood of *Coniferæ*, corresponding in their structure to the *Araucariæ* of the present time; for we meet with entire trees flattened and converted into fibrous coal. The *Sigillariæ*, *Stigmariæ*, *Lycopodiaceæ*, containing a softer kind of parenchym, have commenced to decompose and crumble, whilst the harder *Araucariæ*, whose decomposition had not so far advanced, were either incorporated into the mass, or floated until the process of decomposition was terminated, by the whole becoming covered. In fibrous coal, the structure of the wood, the parenchymatic cells of the wood, and the radial lines of the pith, are stated to be perceptible without difficulty by the aid of a lens. (It cannot be denied that the advanced state of decomposition which these views assume for fibrous coal, is rather puzzling; for English fibrous coal from St. Helen's is of such a nature that it is impossible to burn it in a platinum crucible, heated in an ordinary flame. In the same locality, fibrous coal is, moreover, found so regular and homogeneous between the different strata, and in the clefts, that it is difficult to understand how the uniformity possessed by this deposit of the wood of *Coniferæ* upon a coal-seam, during the period of its formation, could have occurred. Göppert has endeavoured to support his views respecting the formation of coal in the moist way, by experiment. He allowed plants to remain for some time under water whose temperature was 100° during the day, and from 62° to 75° during the night, and found that in many cases one year, in others two years, sufficed to convert these plants into a product which, in external appearance, could no longer be distinguished from brown-coal. Ordinary coal (pit-coal) could not be obtained, except by addition of some green vitriol to the water, ½ drachm to 6 oz. of plants. He does not believe that the natural formation of coal has taken place at so high

Fibrous coal.

a temperature; time might have produced the same effect, and the temperature used in the experiment had been merely employed with the view of accelerating the process.

Göppert is, moreover, of opinion that the formation of fossil resins—f. i. of amber—might be illustrated by his method. Venetian turpentine, when submitted, together with the branches of *Pinus larix,* to a similar process, after the lapse of a year, had lost its peculiar odour, and, more or less of the faculty of dissolving in spirits of wine.

Almost simultaneously, Lyell(1) has brought forward the same view respecting the formation of coal. Lesquereux(2) gives a similar theory.

Binney(3), likewise, is of opinion that the plants converted into coal grew upon the spot where the coal is found; the presence in coal of *Nautilus, Goniatites,* &c., leads him to believe that they have grown in salt marshes, although *Cypris* and *Unio* are also found.

Pitch-coal.—A communication on the brown-coal from Pütschen, on the Hardt, was presented in 1847 to the Niederrheinische Gesellschaft für Natur- und Heilkunde at Bonn, by Nöggerath(4). A third of the total amount of coal raised in that locality has the property of ordinary bituminous wood, but is converted, upon drying, into beautiful pitch-coal, with perfectly conchoidal fracture, and a very characteristic fatty lustre. It is well known that in other localities—f. i. at the Meissner—the pitch-coal is taken ready formed from the earth. Bischof has made some experiments, in order to elucidate the cause of this transformation. Lumps of this coal were introduced into bottles in the mine, and subsequently dryed under the bell of the air-pump, by means of sulphuric acid. After a few days, they were found to be actually converted into pitch-coal. Specimens of the same coal, when kept for a period of 8 days in stoppered bottles, had absorbed 11 per cent of the oxygen in the enclosed air, without giving rise to the formation of carbonic acid. The coal had not been changed in the slightest degree. The

(1) Sill. Am. J. [2] III, 39.

(2) Quelques recherches sur les marais tourbeux en général, Neufchatel, 1844; Mém. Soc. Scienc. Nat. Neufchatel, III; Arch. Ph. Nat. VI, 154, 158.

(3) Phil. Mag. [3] XXXI, 259; Manchester Literary and Philosoph. Society's Memoirs, VII; Arch. Ph. Nat. VI, 242.

(4) Jahrb. Miner. 1848, 603.

Pitch-coal. conversion, therefore, is essentially due to desiccation, although this does not exclude the assumption of the action of oxygen being co-operative in the process, inasmuch as coal, dried in a warm room, was found to be more perfectly converted than the lumps under the air-pump. It would accordingly appear that native pitch-coal had met with conditions of desiccation in the seams, by the intrusion of basalt, the heat of the rock, disturbance of the seam, and exposure to the atmosphere, &c. The absorption of oxygen would explain the occurrence of choke-damp in brown-coal mines.

Imatrastone.—Parrot(1) had ascribed organic origin to the well-known concretionary formations, which are found in the hills of travelled materials of Finnland. He had taken them for petrified mollusca, and based his opinion upon the assertion that he had found in them both sulphur and lime, although they occur in rocks containing not a trace of these constituents. Virlet(2), on the contrary, believes them to be merely nodules of calcareous clay, generated by molecular attraction. The analysis of imatrastones, made at his suggestion by Salvétat, shows that the clayey sand, which is mixed with the lime, had a very variable composition, but was *invariably free from sulphur*. He found carbonic acid 21·03, lime 26·77, water 2·51, silicic acid 34·06, alumina 9·00, proto-sesquioxide of iron 4·00, sesquioxide of manganese 2·00, alkali 0·49, titanic acid and manganese, traces, loss 0·14.

Coprolites.—Dana(3) has analysed the coprolites from the sandstone in the valley of the Connecticut. These coprolites occur together with the well-known footmarks. They contain basic phosphate of lime and magnesia 39·60, carbonate of lime 34·77, urate of ammonia and lime 3·00, chloride of sodium 0·50, sulphate of lime and magnesia 1·75, organic matter and water 7·30, sandstone-particles 13·09.

Aerolites.—Rammelsberg(4) has made a new analysis of the aerolite of Juvenas, so well known by the mineralogical investigation of G. Rose, who had found it to be composed of augite, labradorite and magnetic iron-ore. Shepard(5) had asserted that the felspathic

(1) Petersb. Acad. Bull. 1839, VI, 183; Jahrb. Miner. 1840, 714; Bronn's Geschichte der Natur, I, 235.

(2) Bullet. Géolog. II, 219, and IV, 22.

(3) Jahrb. Miner. 1847, 729.

(4) Pogg. Ann. LXXIII, 585.

(5) Sill. Am. J. [2] II, 377.

constituent of this aerolite was anorthite, an opinion which has been confirmed by Rammelsberg. On analysis, he obtained 36·77 parts of constituents decomposed by acids (A), and 63·23 parts not decomposed by acids (B). Composition :

	SiO_3.	Al_2O_3.	Fe_2O_3.	CaO.	MgO.	NaO.	KO.	PO_5.	FeS.	FeO.	TiO_2.	FeO,Cr_2O_3.
A	44·38	33·73	3·29	18·07	0·36	1·03	0·33	0·54	0·71	—	—	—
B	52·07	0·24	—	5·68	9·98	0·41	—	—	—	30·81	0·16	2·13

The aerolite of Juvenas contains, therefore, anorthite (about 36 per cent), augite (about 60 per cent), chrome-iron (1·5 per cent.) magnetic iron-ore ($\frac{1}{4}$ per cent), and perhaps small quantities of apatite and titanite.

Aerolites from the River Don. — Borissiak(1) of Charkow has described an aerolite which fell on October 30, (old style?), 1848, about thirty wersts to the south-east of Werchne Tschirskaja Stanitza, at the River Don. The stone has the form of a three-sided pyramid, with one concave, one convex and one plane face. It weighs 8 kilogr. and 30 grms. and has a spec. grav. = 3·58. By means of the magnet about 30 per cent of metallic particles may be removed. The whole stone, with the exception of the four corners, is surrounded by a crust about $\frac{1}{6}$th of an inch in thickness, which is of a dull-black colour, and of a hardness sufficient to scratch glass; it is very brittle, and interpenetrated with particles of iron. The interior mass is of a coarse earthy texture, of a light-grey colour and dull fracture; it is intersected with delicate veins, some of which are filled with a blackish substance. Infusible before the blow-pipe, but changing colour and becoming magnetic. With borax it yields a vitreous slag, which becomes black on cooling. Only partially soluble in acids, more so in hydrochloric than in sulphuric acid, in the former with a slight evolution of hydrosulphuric acid. In the trachyte-like mass were found metallic iron, sulphide of iron, small scarcely perceptible irregular white grains, resembling orthoclase, and brilliant, blackish globules, of the size of a pin's head, which were attracted by the magnet.

Aerolites of Braunau. — The fall of aerolites near Braunau, in Bohemia, is one of the most remarkable phenomena of this kind hitherto observed. Accounts of the details of the fall and descriptions of the

(1) Petersb. Acad. Bull. V, 196; Pogg. Ann. Ergänzungsb. II, 366.

Aerolites of Braunau.

masses have been communicated by Humboldt(1), Göppert and Boguslawski(2), Weiss(3) and Beinert(4); the latter has published a separate pamphlet upon the subject(5). The phenomenon took place July 14, 1847, at 3 o'clock in the morning, when two masses fell, one of which, weighing 42 pounds and 3 ounces, had retained, even 6 hours after the descent, so much heat that it could not be touched. The latter had the form of an irregular cube with concavities, exhibiting rather distinct six-sided, somewhat longitudinal cells. The exterior of the masses is of an iron-grey colour, the cells are lined with a yellowish-brown coating, exhibiting mica-like plates of metallic lustre. The fracture of the mass is distinctly crystalline, somewhat foliaceous, and shows a metallic lustre intermediate between those of lead and zinc. Spec. grav.=7·7142. Hardness very considerable. A second mass fell through the roof of a house; it weighs 30 pounds 8 ounces, and differs from the former merely by its shape which is that of a colossal oyster-shell. The six-sided cavities of this second mass are deeper and more perceptible; they contain a large amount of reddish-brown oxide.

Glocker(6), Neumann(7) and Haidinger(8) have made observations upon the crystalline structure of this iron, and of meteoric iron in general. Glocker is of opinion that the Widmanstättenian figures exhibited by meteoric iron are owing to the dense accumulation of imperfectly formed octohedrons, although octahedral structure could not be proved by direct observation in iron(9). Artificially prepared iron, on the other hand, is stated to exhibit a foliaceous structure, parallel with the planes of a cube, and a similar structure became perceptible in the meteoric iron of Braunau and Seeläsgen by fracture. The fracture of both was crystalline foliaceous, showing three perfectly equal planes of structure at right angles with each

(1) Compt. Rend. XXV, 627.

(2) J. Pr. Chem. XLII, 59, 428; Schles. Ztg. 1847, 24 Nov.; Haidinger's Berichte, (comp. II, 379) III, 493.

(3) Berl. Acad. Ber. 1847, 391.

(4) Pogg. Ann. LXXII, 170.

(5) Der Meteorit von Braunau, Breslau 1848.

(6) Pogg. Ann. LXXIII, 332.

(7) Oestr. Blätter für Lit. u. Kunst 1848, 26; Jahrb. Miner. 1848, 825; Haiding. Berichte IV, 86.

(8) Haiding. Berichte III, 302, 378; Pogg. Ann. LXXII, 582.

(9) Haiding. Berichte III, 303; it deserves, however, to be noticed that the iron from Arva, in the collection of Vienna, is stated to consist of octahedral and tetrahedral fragments.

Aerolites of Braunau.

other; when suddenly broken they exhibit a very sharp hackley fracture. In the iron of Seeläsgen, this structure is still more distinctly perceptible, the edges and corners being even larger than in foliaceous galena. Meteoric iron has no cleavage in the ordinary acceptation of the term, inasmuch as the separation according to the planes of structure does not take place on percussion with a hammer; it is only by breaking that the hackley fracture, or the above crystalline planes of structure, become perceptible, which cannot, however, be separated any farther in the direction of the crystalline faces. The term cleavage, therefore, cannot be properly used in this case, inasmuch as cleavability is an external property which may or may not attend crystalline structure, but which is never found without the latter.

Haidinger found the meteoric iron from Braunau, which is in the collection of Vienna, to exhibit a perfect cleavage, and the planes of cleavage parallel to the three directions of the cube. Irrespectively of the toughness of the iron, the separation may be effected almost as easily as that of galena. The same observer states that he has found beautiful Widmanstättenian figures; all these figures belonged to one system, which appeared to indicate that the whole piece of iron consisted of one individual crystal; hence he concludes that it has been produced during a very slow process of formation.

Neumann found amongst the crystalline faces, obtained by the cleavage of this iron, only such as belong to a hexahedron, the most perfect direction of cleavage corresponding to one hexahedron, the less distinct ones to hexahedrons occupying, in relation to the former, the four possible geminal positions. In order to determine the lines, which are produced by etching, two cuts were made, one parallel to the planes of the hexahedrons produced by cleavage, the other in the direction of the planes of an octahedron corresponding to the hexahedron in question. The hexahedral cut exhibited lines in six directions, the octahedral cut showed nine directions, but not uniformly distributed over all parts of the plane. These lines exactly correspond to the lines of intersection produced by the hexahedral cut and the planes of the four hexahedrons which occupy the geminal positions relative to the hexahedron, whose planes are parallel to the cut. It is the position of these lines of intersection which determines the figures delineated by etching in meteoric iron. The hexahedral planes, parallel to which the cleavage is most perfect, are not indicated by the etched lines. As to the crystalline structure, the whole mass is composed of thin layers parallel to the planes of a geminal hexahedron; there are, moreover, layers resisting to

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solvents with more or less force, and intersecting each other in such directions as correspond to six other octahedrons, of which, in each case, three may be in geminal combination with one of the hexahedrons belonging to the first geminal system. In the direction of the lines of intersection, a somewhat more soluble iron-compound, probably schreibersite, is deposited, whose removal during the process of etching produces the delineations upon meteoric iron. The different layers may also be traced by the different degree of lustre possessed by the etched planes.

Analyses of these aerolites have been communicated by Fischer and Duflos(1), and by the former chemist alone(2). It appears from these researches that this meteorite contains three different substances.

1. The chief quantity of the mass, from 95 to 98 per cent, consists of iron 91·882, nickel 5·517, cobalt 0·529, copper, manganese, arsenic, calcium, magnesium, silicium, carbon, chlorine, sulphur 2·072.

2. A substance occurring in many places in larger or smaller pieces, which may be separated by mechanical means; it is a compound of protosulphide of iron with nickel. This compound is soluble in hydrochloric acid, with the exception of a small residue of about 1 per cent, containing chromium, carbon and silicic acid.

3. The third body which remains after treatment with hydrochloric acid consists of small thin greyish-white, very brilliant brittle plates, strongly magnetic, and partially exhibiting in a distinct manner the form of rectangular tables; this residue contains, moreover, a greyish-white brilliant powder, of an analagous nature. Composition: iron 56·430, nickel 25·015, phosphorus 11·722, chromium 2·850, carbon 1·156, silicic acid 0·985; it closely agrees with the so-called schreibersite. According to Fischer, it is this body which gives rise to the Widmanstättenian figures, an opinion which Berzelius had expressed at an earlier period.

These three substances are more or less perfectly crystallised; all of them are magnetic; the principal mass and the little plates are only retractory, the latter even more so than iron; the sulphide of iron, however, is also attractory.

The presence of bromine, which, according to Humboldt's communication to the Institute of France, Fischer had detected in the Braunau aerolite, has not been confirmed by a closer examination.

(1) Pogg. Ann. LXXII, 475; Jahrb. Miner. 1847, 853; Compt. Rend. XXV, 627; Sill. Am. J. [2] V, 338; VII, 171.

(2) Pogg. Ann. LXXII, 575; LXXIII, 590; Jahrb. Miner. 1848, 320.

The meteoric iron of Braunau is one of the three, the fall of which has been actually observed.

Aerolites of Seeläsgen.

Aerolites of Seeläsgen.—The meteoric iron of Seeläsgen (in the district of Schwiebus, near Frankfort-on-the-Oder), which was found in December, 1847, at a depth of seven yards in the earth, has been described by Göppert, Glocker(1), Partsch(2) and W. G. Schneider(3); it has been analysed by Duflos(4) and by Rammelsberg(5). According to Schneider, the mass weighs 218 lbs., and greatly resembles in its outward appearance the meteoric iron of Braunau. It is covered with a coating of blackish-brown sesquioxide of iron, in some places not thicker than a sheet of paper, but having generally a thickness of from $\frac{1}{4}$ to $\frac{3}{4}$ Parisian lines. Its shape is irregular, partly spherical, partly oval, with a broad basis and an obtuse point. The height of the mass is 1 foot $2\frac{1}{4}$ inches (Par.) The smaller diameter of the base is $10\frac{2}{3}$ inches, the larger one 1 foot $\frac{3}{4}$ of an inch. The largest circumference is 3 feet $3\frac{5}{6}$ inches. The surface exhibits many alternating flat and deep cavities, and in some places strongly projecting protuberances. The interior consists of compact native iron, extremely soft, of a light steel-grey colour, with a yellowish lustre, which is penetrated by delicate zig-zag crevices. Iron pyrites is disseminated through the mass in considerable quantity; sometimes in small aggregated portions, sometimes in isolated nuclei of varying sizes, either spherical, having a diameter of from $\frac{1}{12}$ to $\frac{2}{12}$ of an inch, or cylindrical, having a diameter of $\frac{1}{3}$, $\frac{1}{2}$, and even $\frac{2}{3}$, and a length of $\frac{1}{12}$ to $\frac{3}{12}$ of an inch. The mass is acted upon by hydrochloric acid only after long ebullition. The fracture is finely grained, and remarkably foliaceous and almost tin-white upon the planes of structure, which exhibit beautiful rectangular crystalline faces; in the other parts it breaks like a slag and is hackley. Etching does not produce the Widmanstättenian figures, a statement which is confirmed by Partsch, but only granular projections, interrupted by short delicate lines, the majority of which follow the same direction. The spec. gravity is at 16^0, 7·59 according to Partsch, from 7·63 to 7·71 according to Duflos, and 7·7345 according to Rammelsberg. Hardness, according to Partsch,=4·0. Duflos has analysed only

(1) Bresl. Ztg. 1847, 8, 9, Dec.; Haiding. Berichte (comp. II, 379) III, 471; Pogg. Ann. LXXIII, 329; J. Pr. Chem. XLII, 431.

(2) Wien. Acad. Ber. I, 153.

(3) Pogg. Ann. LXXIV,57.

(4) Pogg. Ann. LXXIV, 61; Jahrb. Miner. 1848, 808; Ann. Ch. Pharm. LXVI, 260.

(5) Pogg. Ann. LXXIV, 443.

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the principal mass; his experiments leave undecided the nature of the admixed sulphide of iron and of the residue remaining upon treatment with hydrochloric acid. He found: iron 90·000, nickel 5·308, cobalt 0·434, manganese 0·912, copper 0·104, silicium 1·157, residue 0·834. He states that the substance disseminated in the principal mass, chiefly consists of sulphide of iron; when treated with hydrochloric acid, it leaves brilliant metallic plates of graphite, and a brown strongly staining residue which appears to indicate silicium and chromium.

Rammelsberg found that treatment with hydrochloric acid leaves a residue, in which three different substances may be distinguished: 1. A light powder of charcoal; 2. Plates of graphite; 3. A heavy metallic, nearly silver-white powder, containing a great many acicular crystals, perceptible by the aid of a lens. The result of analysis was as follows:

Fe Mn.	Ni.	Co.	Sn Cu.	Si.	C.	Total.
92·327	6·228	0·667	0·049	0·026	0·520	0·183

The granular sulphide of iron which is present has a spec. grav. 4·787, a number which is perhaps somewhat too high, on account of an admixture of iron; this substance has been described under the name of iron-pyrites, but unjustly so, for it is soluble in hydrochloric acid. It contains:

S.	Fe.	Ni Co.	Co.	Cu.	FeO.	Cr_2O_3.
28·155	65·816	1·371	1·371	0·566	0·874	1·858

Rammelsberg is of opinion that the nickel is present in the form of nickeliferous iron. After deducting from the total amount of sulphur the quantity which is necessary to convert the copper into Cu_2S, iron and sulphur remain in the proportion of the protosulphide, not in that of magnetic iron-pyrites.

The residue left after treatment with hydrochloric acid is a mixture of white silicic acid (perhaps from the glass), of light, loose charcoal, and of brilliant plates of graphite; it contains, moreover, a large quantity of metallic particles, exhibiting under the microscope a white lustre; they are probably residues of the principal mass of iron which had been left undissolved by the acid. After the charcoal and silicic acid had been separated by lixiviation, two analyses gave the following results:

	S.	P.	Fe.	Ni.	Cu.	Sn.
1.	—*	6·13	59·23	26·78	0·78	0·20
2.	0·26	7·93	61·13	28·90	*	

* Not determined.

Owing to this mixed condition, the nature of this substance,

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originally obtained by Berzelius in the investigation of the aerolites of Bohumilitz, Siberia and Elbogen, and subsequently examined by Silliman and Hunt, who procured it from those of Texas and Lockport, was hitherto very imperfectly understood. Shepard has designated it by the term dyslitite, whilst he assigns the name schreibersite to small striped prisms, discovered in the meteoric iron of Bishopville, and which he believes to be sulphide of chromium.

The quantity of carbon, according to Rammelsberg, is 0·52 per cent.

Meteoric Iron of Arva.—Patera and Löwe(1) have examined the meteoric iron of Arva. The former found the spec. grav. to be 7·814.

	Patera.			Löwe.	
Iron	89·42	93·13	94·12	90·471	91·361
Nickel	8·91	5·94	5·43	7·321	7·323
Cobalt and Copper	trace	trace	trace	trace	trace
Silicium and carbonaceous residue	1·41	—	—	1·404*	0·938
Sulphur	—	—	—	traces	—

* With metallic spangles of yellow colour.

Patera(2) found, moreover, the same metallic compound in light steel-grey plates and grains, which Berzelius has observed in the meteoric iron of Bohumilitz, but omitted to denominate. They are flexible, and exceedingly magnetic. Hardness = 6·5; spec. grav. from 7·01 to 7·22. They contain, according to the mean of three analyses: phosphorus 7·26, iron 87·20, nickel 4·24, together with some carbon, the amount of which was not determined. Patera and Haidinger propose the name of *Schreibersite*, which name had previously been given by Shepard to another meteoric mineral. Haidinger is accordingly inclined to apply to Shepard's schreibersite the term shepardite, retaining the name of schreibersite for the mineral of Arva.

The fall of aerolites in Hungary has been described by Stedler(3).

(1) Oestr. Blätter für Lit. 1847, No. 169, p. 670; Haiding. Berichte (comp. II, 379) III, 62, 70; Jahrb. Miner. 1848, 698; 1849, 199; J. Pr. Chem. XLVI, 183.

(2) Oestr. Blätter für Lit. 1847, No. 175, 694; Description of the iron and of the locality where it was found, Wien. Ztg. 17, April 1844 and March 1845.

(3) Oestr. Blätter für Lit. 1847, 343; Jahrb. Miner. 1848, 64; Haiding. Berichte III, 282.

Meteoric iron of Schönenberg.

Meteoric Iron of Schönenberg.—Schafhäutl(1) has reported upon the fall of an aerolite, weighing 14 lbs. 8½ oz., near Schönenberg in the Mindel-Valley, County of Schwaben, district of Burgau, which took place December 25, 1846 (2). This aerolite is now in Munich.

American Meteorites.—Shepard(3) in continuation of his former communication, reports upon twenty-three American aerolites, from which we quote the more interesting and more minutely described cases. 1. From Walker County, Alabama. This specimen was previously (1845) described by Troost. Pear-shaped mass of iron, weighing 165 lbs., found remote from any settlement, with the thicker end buried in the ground. It was without any abrupt prominences or depressions, and covered by a smooth black crust. It did not afford, by etching, the Widmannstättenian figures, although it exhibited glistening freckles, or angular spots of the size of fine grained gun-powder, which were occasionally intermingled with shining lines and fibres; spec. grav. 7·265. It contained 99·89 of iron, mixed with calcium, magnesium, and aluminum.

2. From Scriba (Oswego) New York. This mass was discovered by Mr. Prendergast in the possession of a blacksmith who had found it in the vicinity of his coal-pit. It was very similar to the preceding specimen; and had the same smooth surface and black crust, the same freckles after etching, and the same composition. The external form, the freckles, the fused crust, together with the remote place where it was found, induced Shepard to claim for these two masses a meteoric origin, although the characteristic admixtures are absent, which are usually found in meteoric iron.

3. From Babb's mill, ten miles north of Greenville, Green County, Tennessee (previously described by Troost in 1845). In this place two masses were found, one of which weighed from 12 to 14 lbs.; it had a fine grained crystalline structure, and consisted of malleable iron. The second mass, weighing about 6 lbs. is in the possession of Mr. Shepard; it exhibits the depressions with blunt rounded angles and edges, which are usually found in meteoric iron, and is covered with broad patches of a thin, yellowish, ochrey brown incrustation; spec. grav. 7·548. It is close grained and perfectly compact, taking a very high polish, and exhibiting at the same

(1) Augsb. Allg. Ztg. 1847, 1. Jan.; Pogg. Ann. LXX, 334.
(2) Münchener gelehrte Anz. 1847, XXIV, 553.
(3) Sill. Am. J. [2] IV, 74.
(4) Sill. Am. J. [2] II, 392.

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time a colour rather whiter than that of steel. It shows no Widmanstättenian figures, on being corroded with nitric acid, although on very close inspection, minute, whitish spots (isolated and collected into patches) may be seen here and there, scattered without order over the surface. Fracture fine granular; lustre silvery. Troost found (probably in the larger mass) iron 87·58, and nickel 12·42; remarking, however, that the ratio of nickel given was probably too high, and that the mass might contain other ingredients. Shepard found his piece to consist of iron 85·30, and nickel 14·70, together with traces of calcium, magnesium and aluminum.

4. From Burlington, Otsego County, New York. This mass, ploughed up in 1819, originally 150 lbs. in weight, has been previously described by Silliman. At present its weight has been diminished to about a dozen pounds, portions having been cut off from time to time. It is coarsely crystalline and of a hackley fracture. Its polished faces show a very high lustre, with a colour of nearly the same whiteness as German silver. Exhibits the Widmanstättenian figures. Hardness very considerable. Composition according to Rockwell, iron 92·291, nickel 8·146. Shepard found iron 95·200, nickel 2·125, insoluble matter 0·500, sulphur and loss 2·175.

5. From Asheville, Buncombe County, North Carolina(1). Shepard states that this meteorite contains cobalt, magnesium, and phosphorus; the amount of nickel is as high as 5 per cent, that of the silicic acid considerably below 0·5 per cent.

6. From Hommoney Creek, Buncombe County, North Carolina. The mass weighing nearly 27 lbs. was found near an old house. It is rather flat on one side, as though it had been laid, when semi-fluid, on a somewhat plane surface, whilst its other sides are irregular, with cavities and various inequalities. The interior is very vesicular and somewhat malleable. Its surface is rather tuberose and jagged, the colour varies in shade from brown to black, sometimes it is variegated (especially in the bottoms of the cavities) with an ash-coloured earthy matter. This last was undoubtedly derived from the circumstance, that the mass was for a considerable time employed as a support for the fuel in the fire-place of a farmer's kitchen. In one spot, nearly buried within the substance of the iron, a few grains of a dull, yellowish, grey olivine were noticed. Near the surface, the structure is eminently vesicular; the cavities, however, grow smaller,

* Die Meteoriten von Partsch, Vienna, 1843, 116.

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as the distance from the surface increases. The fresh fracture has a colour and lustre, intermediate between those of steel and magnetic iron-pyrites. Etched surfaces exhibit, in a very distinct manner, the most delicate Widmannstättenian figures. Hardness about that of grey cast-iron; spec. grav. 7·32. Composition, iron (with traces of chromium and cobalt) 98·19, nickel 0·23, carbonaceous insoluble matter, and loss 1·58. The yellowish olivine-like grains consist of silicic acid and lime, magnesia and sesquioxide of iron.

7. From Lockport, New York. In addition to the constituents previously pointed out, nickel, copper, phosphorus and silicic acid, Shepard detected cobalt.

8. From the Black Mountain, head of Swannanoah River, North Carolina. The fragment weighs only 21 ozs. and is evidently a portion of a mass that must have been much larger. Its texture is throughout highly crystalline, having all the laminæ (which are $\frac{1}{10}$ inch thick) conformably to the octahedral faces of a single individual. These layers adhere to one another with much tenacity; the particles are somewhat oval in form; a result which seems to be due to the existence of very minute veins of magnetic iron-pyrites. The mass contains several rounded and irregular nodules of a graphite-like substance (from $\frac{1}{2}$ to 1 inch in diameter) with which foliated magnetic iron-pyrites occurs; spec. grav. = 7·261. Composition: nickel with traces of cobalt 2·52, iron 96·04, insoluble matter, sulphur, and loss 1·44.

9. From Cocke County, Cosby's Creek, Tennessee(1). The original mass, which had been used, with the exception of a small piece of 1 lb., was an oblong rectangular block, weighing about 2000 lbs. and containing a great quantity of large perfectly octahedral crystals. Another mass weighing 112 lbs. was found in the vicinity of the former. It was malleable, very white, and easily cut with a sharp instrument. In other respects, both masses were identical.

10. From Randolph County, North Carolina. This mass,(2) originally 2 lbs. in weight, is distinctly foliated, the laminæ being thin, and much interlaced. Colour and lustre like that of mispickel. When etched, it presents very fine, almost invisible feathery lines, much resembling hoar-frost on a window-pane. Hardness equal to that of the best tempered steel; spec. grav. 7·618. The only

(1) Previously described by Troost, Sill. Am. J. XXXVIII, 250, and by Shepard, Ibid. XLIII, 354, also by Partsch, die Meteoriten, 151.

(2) Described by Shepard, Sill. Am. J. XVII, 140.

metal Shepard has been able to detect in this steel is cobalt, and this only in traces. He found, moreover, a reddish-brown powder, insoluble in nitro-hydrochloric acid, which he considered as silicic acid.

11. Meteoric iron from Otsego County, New York. Its weight was 276 grs. and its figure almost spherical. It was covered with a black coating, and exhibited a foliated or foliated-columnar structure, the columns radiating from the centre to the circumference. Its colour was a light steel-grey, with a faint yellowish tinge; somewhat analogous to that of magnetic iron-pyrites. Through the mass there were disseminated very minute perfectly round globules of magnetic iron-pyrites, which were easily detached, leaving behind cavities with smooth silvery walls. When etched, it exhibited a beautiful crystallisation. It contains 94·57 per cent of metallic iron, together with copper, nickel, cobalt, sulphur, carbon, tin (?) and perhaps chromium.

12. Shepard(1) gives some particulars respecting a very remarkable fall of stones in Linn County, Iowa, February 25, 1847. The fragments Shepard obtained from these stones, which weighed from 40 to 50 lbs., exhibited small globules of nickeliferous iron, dispersed through a greyish felspathic mass.

13. For an account of the fall of a meteorite near Castine, Maine, May 20, 1848, we are indebted to Cleaveland and Shepard(2). The stone weighed $1\frac{1}{2}$ lbs.; it had a black coating, and a somewhat wedged shape: one surface was nearly even, the other irregular and slightly undulated. Spec. grav. = 3·456. It resembles, in its general appearance, the Poltawa stone (March 12, 1811), it is however, of a much lighter colour, and exhibits a more nacreous lustre, but no spots of rust. The nickeliferous iron, which is disseminated through the mass, is of an unusual silvery lustre. The magnetic iron-pyrites present shows a similar appearance. A few delicate black dots may be distinguished, moreover, which show before the blow-pipe the reaction of chromium, and are probably chrome-iron. The malleable iron was extracted by means of the magnet, and amounted to 11·22 per cent of the whole stone. It contained iron 85·3 and nickel 14·7. The earthy constituents of this stone, which is soluble in concentrated hydrochloric acid, appears to be a trisilicate of protoxide of iron and magnesia, a mineral frequently found in meteorites, and which Shepard proposes to

(1) Sill. Am. J. [2] IV, 288, 429; Pogg. Ann. LXXIV, 320; Jahrb. Miner. 1848, 850.

(2) Sill. Am. J. [2] VI, 251.

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describe under the name howardite in a subsequent communication.

Silliman, Jun. and Hunt(1) have analysed the meteoric iron of Texas and Lockport. They found in the former iron 90·911, nickel 8·462, phosphides, carbon, copper, antimony (or possibly a new element) 0·500. The latter contains iron 92·583, nickel 5·708, copper and arsenic traces, insoluble residue 1·4. Both varieties exhibited, when etched, Widmannstättenian figures.

Silliman, Jun.(2) describes a meteoric stone, the fall of which was observed in Concord, New-Hampshire in October, 1846. The external surface of this stone, which weighs 370½ grs., is glazed with a brilliant enamel of a greyish-white, with occasional patches of deep-brown metallic stains. The interior is scoriaceous, like the frit produced by the partial fusion of felspar. The porous character of the mass rendered an accurate determination of the spec. grav. impossible. Its hardness is about 6·5, and it easily scratches felspar. The larger part of this stone is quite white in colour, and the fracture has a vitreous lustre. The whole bears every mark of having been intensely heated. The portions which have the iron stain are small and exhibit, even under the microscope, no metallic points. Before the blow-pipe it dissolves with effervescence in carbonate of soda, and yields on cooling an almost opaque glass. Alone, in the platinum forceps, it fuses on the edges, and emits a phosphorescent light, imparting at the same time a clear soda-yellow to the flame. Composition: silicic acid 84·973, magnesia 12·076, soda 2·218, loss 0·233. These numbers lead to the formula MgO, 3 SiO_3, NaO, SiO_3, approaching that of a mineral found by Shepard in the meteoric stone of Bishopville in South Carolina, for which he has proposed the name chladnite.

Troost(3) describes a meteoric iron, found at Murfreesboro', Rutherford County, Tennessee, from which district the same inquirer had obtained not less than ten other aerolites which have all been described in Silliman's Journal. The mass, the fall of which was not observed, weighed about 19 lbs; it had an irregular oval shape, and was coated with a crust of about 2 millimeters in thickness, resembling brown iron-ore. The metal has the lustre of iron, and a crystalline fracture; it is malleable, but somewhat harder than the

(1) Sill. Am. J. [2] II, 370; Pogg. Ann. LXXI, 544; J. Pr. Chem. XLII, 458; comp. Rammelsb. Handw. 3. Suppl. 80.

(2) Sill. Am. J. [2] IV, 353.

(3) Sill. Am. J. [2] V, 351.

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other meteorites from Tennessee, inasmuch as more time was required for dividing it by means of a saw. Polished surfaces show Widmanstätenian figures of a rhombic and triangular form. It appears to be nearly free from foreign admixtures. The cut exhibits, however, a circular mass, of $\frac{3}{10}$ of an inch in diameter, which Troost considers as sulphide of iron (magnetic iron-pyrites); on the other surface two small cavities are perceptible, the one being $\frac{1}{5}$, the other $\frac{1}{10}$ of an inch in diameter. With these exceptions, the metal is homogeneous and compact. An approximative analysis showed less nickel than has been found in any other specimen of the Tennessee meteorites, namely, iron 96·00, nickel 2·40, and 1·60 of insoluble substances not farther investigated.

Shepard(1) has given a synopsis of all the facts known with respect to aerolites, which we cannot pass over, as it contains a variety of new statements. According to the author, the number of mineral species observed in these bodies amounts to 37, of which those marked † are peculiar to the meteorites. Sulphurous acid(a), sulphate of magnesia, sulphate of soda, † hyposulphite of soda, † hyposulphite of magnesia, chloride of calcium, chloride of magnesium, † soluble silicic acid(b), † sulphate of protoxide of nickel(c), sulphate of protoxide of iron(d), † sesquichloride of iron(e), † protochloride of nickel(e), † protochloride of cobalt(f), chloride of sodium(g), apatite(h).

Apatoid (c and i) small yellow, half-translucent grains. Hardness 5·5. Fuses on charcoal before the blow-pipe, and becomes black. Dissolves in borax, forming a greenish-yellowish glass. Contains no phosphoric acid.

† Sphenomite (Shepard), greyish-brown crystals with a tint of yellow; tubular, and very small. Hardness 5·5. It occurs upon black crystals of augite, and, interlaced with anorthite, in the stone of Juvenas. It yields, before the blow-pipe, a black magnetic glass; it dissolves in borax with effervescence, and exhibits the reactions of

(1) Instit. 1847, 379, from Rep. Amer. Geolog. Assoc.; Beinert, der Meteorit von Braunau, Breslau, 1848, 30; Arch. Ph. Nat. VI, 332.

(a) In almost all meteorites in the moment of their fall; easily perceptible in the stone of Bishopville, by fracture or friction.

(b) All in the aerolite of Bishopville.

(c) In the aerolite of Alais (Berz.)

(d) In the aerolite of Cocke County, Tennessee.

(e) In the aerolite of Clairborn, Ashville, North-Carolina.

(f) In a red rain near Blankenburg, Journ. de Phys. LXI, 469.

(g) In the aerolite of Stannern.

(h) In the aerolite of Richmond.

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sphene. It is soluble in nitric acid, a heavy white powder, insoluble in ammonia, being left. The solution contains silicic acid and lime.

† Dyslitite (Shepard); a brownish-black powder remaining behind on dissolving a very great number of meteoric masses in acids. From 0·25 to 2·25 per cent of the masses. (This is the schreibersite of the German mineralogists. Comp. the analyses of the meteoric masses of Braunau, of Seelässgen, and of Arva.)

Mica (i).

† Iodolite(b) (Shepard), occurs in compact, angular, slightly rounded grains, the largest of which have $\frac{1}{8}$ of an inch in diameter. Three directions of cleavage, which are, however, rather indistinct. Colour smalt-blue; lustre resembling that of nitre. The grains are semi-translucent, and easy to break. Hardness from 5·5 to 6·0. Enter into ebullition before the blow-pipe, and yield an almost colourless turbid glass which, when hot, has a slight amethystine tint. When pulverised and heated with boracic acid upon iron wire, no reaction is perceptible. Readily soluble in hydrochloric acid; ammonia produces a precipitate in this solution, which appears to contain only silicic acid, but not a trace of lime and magnesia.

Anorthite(k).

† Chladnite (Shepard), occurs in imperfect crystals, some of which have as much as 1 inch in diameter. The primitive form is an oblique double prism, which is found together with the forms of felspar and albite. The natural planes are not sufficiently even to admit of measurements. Cleavage, which it readily suffers, leads to angles of 120^0 and 60^0. Colour snow-white, rarely greyish. Lustre nacreous, passing over to that of nitre. Translucent; in pieces which have not been separated, semi-translucent. Hardness from 6·0 to 6·5. Very frangible. Pieces of half an inch in size may be readily crushed between the fingers. Spec. grav. 3·116. When heated alone before the blow-pipe upon charcoal, it forms readily, and with incandescence, a white enamel; with borax it yields slowly a translucent glass. It is a trisilicate of magnesia, and forms almost $\frac{2}{3}$ of the stone of Bishopville.

Augite(g and k).

† Chantonnite (Shepard), in the meteoric stone of Chantonney. Angular solid masses, or black veins. Hardness from 6·5 to 7·0. Spec. grav. 3·48. Fuses before the blow-pipe, at the edges, to a black slag.

(i) In the meteoric iron of Weston. (k) In the aerolite of Juvenas.

Olivine.

Garnet(l).

Limonite, under the crust of oxide with which the iron masses are coated, and under the rust upon the fresh planes of fracture of various stones.

Chrome iron-ore(m).

Magnetic iron-ore. Massive in the veins and the coating of the stone of Scriba; remains also, mixed with dyslitite, in form of a black powder, when certain species of meteoric iron are dissolved in acids.

† Native iron, in the iron of Burlington, Scriba and Walker County, the meteoric origin had become doubtful, although unjustly so, on account of the absence of nickel, chromium, and cobalt. Spec. grav. from 7·26 to 7·5. It is soft, and of a fracture sometimes fibrous, sometimes granular. Its smooth surface shows, like nickeliferous iron, numerous brilliant points, interspersed among projecting lines of a silvery lustre.

† Nickeliferous iron. This name probably embraces several varieties. Spec. grav. from 6·5 to 8·0.

† Native steel in beautifully crystallised masses, generally exhibiting parallel laminæ, confusedly intersecting each other. Hardness from 6·0 to 6·5. Spec. grav. from 7·33 to 7·4. Colour steel-grey. Etching brings out beautiful crystalline figures. It occurs in the masses of Randolph County (North Carolina), and of Bedford County.

Magnetic iron-pyrites. Primary form a rhombic, secondary a six-sided prism; faces of the crystals steel-grey, fracture copper-coloured, slightly yellowish. The crystals are usually hollow, or exhibit roundish cavities. They occur also in foliaceous masses. Spec. grav. 4·454. It was found in the iron of Cocke County, Tennessee. The crystals to which this description refers are contained in the stone of Richmond; they occur, moreover, although of a slightly different form, in the stone of Juvenas.

† Schreibersite(b). Small prisms, deeply striped, with somewhat indefinite corners. Cleavage parallel to the planes of the prism. Hardness 4·0. Lustre imperfectly metallic. Opaque, easily frangible. Disengages before the blow-pipe sulphurous acid without effervescence, a black magnetic glass remaining behind. Yields with borax a beautiful yellow bead, becoming paler on cooling, and

(l) In the aerolite of Nobleboro.

(m) In the aerolite of Ensisheim, and in that of Chassigny.

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assuming sometimes a greenish tint. On addition of tin a green glass is obtained, owing to the presence of chromium. The iron appears to be accidental, and to belong to magnetic iron-ore, adhering mechanically. Schreibersite is probably sesquisulphide of chromium.

Sulphur(b).

Molybdenum(d).

Meteoric Dust.—Within the last few years the fall of meteoric dust has been repeatedly observed; several specimens of this dust have been examined. Unless of undoubted volcanic origin, this dust, as it would appear from Ehrenberg's(1) researches upon the infusoria, it contains, is almost invariably derived from South America; it is kept suspended for some time in the dust-fogs of the zone of the trade-winds, and occasionally carried over to Europe by south-westerly winds (sirocco, föhn), on account of which Ehrenberg proposes the term "dust of the trade-winds." Red dust, deposited from a föhn-wind upon the snows of the Puster-Valley, in the Tyrol, March 31, 1847, and likewise observed in Freysing and Chambery(2), has been examined by Oellacher(3), and by Heinisch and Kanka(4). The former, on the ground of two comparative analyses considers it to be dust from the Sahara, while the latter are inclined to believe, that it is the ordinary dust from the mountains of the district, occasioned by the fall of avalanches, and carried away by north-westerly winds. Ehrenberg pointed out, by microscopic investigation, that it consisted of a great variety of particles, which have not been under the influence of volcanic actions, and exhibit the same composition as the dust regularly falling in the Atlantic, near the Cape Verd Islands. It contains 66 different forms of fresh-water-infusoria.

On the other hand, the dust which fell upon Barbadoes, May 1, 1812, during the eruption of the volcano of St. Vincent, was of volcanic origin. It was likewise microscopically examined by Ehrenberg(6), who found it to consist of vitreous translucent, frequently rounded particles, exhibiting sometimes a brownish or yellow, sometimes a reddish-brown, or even black colour in transmitted light. Interspersed with them were cellular

(1) Berl. Acad. Ber. 1847, 319; 1848, 285.
(2) J. Pr. Chem. XLV, 217.
(3) Wien. Ztg. 1847, 2. Juni, 29. Nov.; Haiding. Ber. (comp. II, 379) III, 430.
(4) Pogg. Ann. LXXIII, 607.
(5) Haiding. Berichte III, 289; Oestr. Blätter für Literatur und Kunst, 13. October, 1847.
(6) Berl. Acad. Ber. 1847, 152.

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particles, closely resembling powdered pumice-stone, and frequently small crystals similar to augite, and exhibiting a greenish colour. Many were colourless. But even this dust contains 19 kinds of organic substances, which are known only as fresh-water and continental formations, a fact leading to interesting geological conclusions, which do not, however, exactly belong to the province of this Report.

Gibbs(1) examined meteoric dust which had fallen upon a British vessel in the Atlantic. This substance, an account of which was published by Ehrenberg(2) at an earlier period, is only attacked with difficulty by hydrochloric acid; it had to be decomposed by hydrofluoric acid. Gibbs found:

Water and organic matter . . .	18·53	Carbonate of lime	9·59
Silicic acid	37·18	Magnesia	1·80
Alumina	16·74	Potassa	2·97
Sesquioxide of iron	7·65	Soda	1·90
Sesquioxide of manganese . . .	3·44	Protoxide of copper	0·25

Particulars respecting the fall of meteoric dust in Vienna have been published, moreover, by Haidinger, Reissek and Ehrlich(3). Reissek is inclined to derive this dust from an eastern country, from the planes of South Russia, whilst Ehrenberg considers it as a a dust of the zone of the trade-winds.

(1) Pogg. Ann. LXXI, 567; Jahrb. Miner. 1848, 488; Berl. Acad. Ber. 1846, 205.

(2) Wien. Acad. Ber. Hft. 2, 138; Haiding. Ber. (comp. II, 379) III, 489; IV, 151 152. 304.

(3) Haidinger's Berichte IV, 313.

TABLE

FOR THE COMPARISONS OF THE CENTIGRADE, REAUMUR, AND FAHRENHEIT THERMOMETERS.

n^0 C. = $\frac{4}{5}$ n^0 R. = $\frac{9}{5}$ n^0 32^0 + F.
n^0 R. = $\frac{5}{4}$ n^0 C. = $\frac{9}{4}$ n^0 32^0 + F.
n^0 F. = $\frac{5}{9}$ (n^0 — 32^0 C. = $\frac{4}{9}$ (n^0 — 32^0) R.

C.	R.	F.	C.	R.	F.	C.	R.	F.
—40	—32	—40	—30	—24	—22	—20	—16	—4
—39$\frac{4}{9}$	—31$\frac{5}{9}$	—39	—29$\frac{4}{9}$	—23$\frac{5}{9}$	—21	—19$\frac{4}{9}$	—15$\frac{5}{9}$	—3
—39	—31·2	—38·2	—29	—23·2	—20·2	—19	—15·2	—2·2
—38$\frac{8}{9}$	—31$\frac{1}{9}$	—38	—28$\frac{8}{9}$	—23$\frac{1}{9}$	—20	—18$\frac{8}{9}$	—15$\frac{1}{9}$	—2
—38·75	—31	—37·75	—28·75	—23	—19·75	—18·75	—15	—1·75
—38$\frac{1}{3}$	—30$\frac{2}{3}$	—37	—28$\frac{1}{3}$	—22$\frac{2}{3}$	—19	—18$\frac{1}{3}$	—14$\frac{2}{3}$	—1
—38	—30·4	—36·4	—28	—22·4	—18·4	—18	—14·4	—0·4
—37$\frac{7}{9}$	—30$\frac{2}{9}$	—36	—27$\frac{7}{9}$	—22$\frac{2}{9}$	—18	—17$\frac{7}{9}$	—14$\frac{2}{9}$	0
—37·5	—30	—35·5	—27·5	—22	—17·5	—17·5	—14	0·5
—37$\frac{2}{9}$	—29$\frac{7}{9}$	—35	—27$\frac{2}{9}$	—21$\frac{7}{9}$	—17	—17$\frac{2}{9}$	—13$\frac{7}{9}$	1
—37	—29·6	—34·6	—27	—21·6	—16·6	—17	—13·6	1·4
—36$\frac{2}{3}$	—29$\frac{1}{3}$	—34	—26$\frac{2}{3}$	—21$\frac{1}{3}$	—16	—16$\frac{2}{3}$	—13$\frac{1}{3}$	2
—36·25	—29	—33·25	—26·25	—21	—15·25	—16·25	—13	2·75
—36$\frac{1}{9}$	—28$\frac{8}{9}$	—33	—26$\frac{1}{9}$	—20$\frac{8}{9}$	—15	—16$\frac{1}{9}$	—12$\frac{8}{9}$	3
—36	—28·8	—32·8	—26	—20·8	—14·8	—16	—12·8	3·2
—35$\frac{5}{9}$	—28$\frac{4}{9}$	—32	—25$\frac{5}{9}$	—20$\frac{4}{9}$	—14	—15$\frac{5}{9}$	—12$\frac{4}{9}$	4
—35	—28	—31	—25	—20	—13	—15	—12	5
—34$\frac{4}{9}$	—27$\frac{5}{9}$	—30	—24$\frac{4}{9}$	—19$\frac{5}{9}$	—12	—14$\frac{4}{9}$	—11$\frac{5}{9}$	6
—34	—27·2	—29·2	—24	—19·2	—11·2	—14	—11·2	6·8
—33$\frac{8}{9}$	—27$\frac{1}{9}$	—29	—23$\frac{8}{9}$	—19$\frac{1}{9}$	—11	—13$\frac{8}{9}$	—11$\frac{1}{9}$	7
—33·75	—27	—28·75	—23·75	—19	—10·75	—13·75	—11	7·25
—33$\frac{1}{3}$	—26$\frac{2}{3}$	—28	—23$\frac{1}{3}$	—18$\frac{2}{3}$	—10	—13$\frac{1}{3}$	—10$\frac{2}{3}$	8
—33	—26·4	—27·4	—23	—18·4	—9·4	—13	—10·4	8·6
—32$\frac{7}{9}$	—26$\frac{2}{9}$	—27	—22$\frac{7}{9}$	—18$\frac{2}{9}$	—9	—12$\frac{7}{9}$	—10$\frac{2}{9}$	9
—32·5	—26	—26·5	—22·5	—18	—8·5	—12·5	—10	9·5
—32$\frac{2}{9}$	—25$\frac{7}{9}$	—26	—22$\frac{2}{9}$	—17$\frac{7}{9}$	—8	—12$\frac{2}{9}$	—9$\frac{7}{9}$	10
—32	—25·6	—25·6	—22	—17·6	—7·6	—12	—9·6	10·4
—31$\frac{2}{3}$	—25$\frac{1}{3}$	—25	—21$\frac{2}{3}$	—17$\frac{1}{3}$	—7	—11$\frac{2}{3}$	—9$\frac{1}{3}$	11
—31·25	—25	—24·25	—21·25	—17	—6·25	—11·25	—9	11·75
—31$\frac{1}{9}$	—24$\frac{8}{9}$	—24	—21$\frac{1}{9}$	—16$\frac{8}{9}$	—6	—11$\frac{1}{9}$	—8$\frac{8}{9}$	12
—31	—24·8	—23·8	—21	—16·8	—5·8	—11	—8·8	12·2
—30$\frac{5}{9}$	—24$\frac{4}{9}$	—23	—20$\frac{5}{9}$	—16$\frac{4}{9}$	—5	—10$\frac{5}{9}$	—8$\frac{4}{9}$	13

C.	R.	F.	C.	R.	F.	C.	R.	F.
—10	—8	14	5	4	41	20	16	68
—9 4/9	—7 5/9	15	5 5/9	4 4/9	42	20 5/9	16 4/9	69
—9	—7·2	15·8	6	4·8	42·8	21	16·8	69 8
—8 8/9	—7 1/9	16	6 1/9	4 8/9	43	21 1/9	16 8/9	70
—8·75	—7	16·25	6·25	5	43·25	21·25	17	70·25
—8 1/3	—6 2/3	17	6 2/3	5 1/3	44	21 2/3	17 1/3	71
—8	—6·4	17·6	7	5·6	44·6	22	17·6	71·6
—7 7/9	—6 2/9	18	7 2/9	5 7/9	45	22 2/9	17 7/9	72
—7·5	—6	18·5	7·5	6	45·5	22·5	18	72·5
—7 2/9	—5 7/9	19	7 7/9	6 2/9	46	22 7/9	18 2/9	73
—7	—5·6	19·4	8	6·4	46·4	23	18·4	73·4
—6 2/3	—5 1/3	20	8 1/3	6 2/3	47	23 1/3	18 2/3	74
—6·25	—5	20·75	8·75	7	47·75	23·75	19	74·75
—6 1/9	—4 8/9	21	8 8/9	7 1/9	48	23 8/9	19 1/9	75
—6	—4·8	21·2	9	7·2	48·2	24	19·2	75·2
—5 5/9	—4 4/9	22	9 4/9	7 5/9	49	24 4/9	19 5/9	76
—5	—4	23	10	8	50	25	20	77
—4 4/9	—3 5/9	24	10 5/9	8 4/9	51	25 5/9	20 4/9	78
—4	—3·2	24·8	11	8·8	51·8	26	20·8	78·8
—3 8/9	—3 1/9	25	11 1/9	8 8/9	52	26 1/9	20 8/9	79
—3·75	—3	25·25	11·25	9	52·25	26·25	21	79·25
—3 1/3	—2 2/3	26	11 2/3	9 1/3	53	26 2/3	21 1/3	80
—3	—2·4	26·6	12	9·6	53·6	27	21·6	80·6
—2 7/9	—2 2/9	27	12 2/9	9 7/9	54	27 2/9	21 7/9	81
—2·5	—2	27·5	12·5	10	54·5	27·5	22	81·5
—2 2/9	—1 7/9	28	12 7/9	10 2/9	55	27 7/9	22 7/9	82
—2	—1·6	28·4	13	10·4	55·4	28	22·4	82·4
—1 2/3	—1 1/3	29	13 1/3	10 2/3	56	28 1/3	22 2/3	83
—1·25	—1	29·75	13·75	11	56·75	28·75	23	83·75
—1 1/9	—0 8/9	30	13 8/9	11 1/9	57	28 8/9	23 1/9	84
—1	—0·8	30·2	14	11·2	57·2	29	23·2	84·2
—0 5/9	—0 4/9	31	14 4/9	11 5/9	58	29 4/9	23 5/9	85
0	0	32	15	12	59	30	24	86
0 5/9	0 4/9	33	15 5/9	12 4/9	60	30 5/9	24 4/9	87
1	0·8	33·8	16	12·8	60·8	31	24·8	87·8
1 1/9	0 8/9	34	16 1/9	12 8/9	61	31 1/9	24 8/9	88
1·25	1	34·25	16·25	13	61·25	31·25	25	88·25
1 2/3	1 1/3	35	16 2/3	13 1/3	62	31 2/3	25 1/3	89
2	1·6	35·6	17	13·6	62·6	32	25·6	89·6
2 2/9	1 7/9	36	17 2/9	13 7/9	63	32 2/9	25 7/9	90
2·5	2	36·5	17·5	14	63·5	32·5	26	90·5
2 7/9	2 2/9	37	17 7/9	14 2/9	64	32 7/9	26 2/9	91
3	2·4	37·4	18	14·4	64·4	33	26·4	91·4
3 1/3	2 2/3	38	18 1/3	14 2/3	65	33 1/3	26 2/3	92
3·75	3	38·75	18·75	15	65·75	33·75	27	92·75
3 8/9	3 1/9	39	18 8/9	15 1/9	66	33 8/9	27 1/9	93
4	3·2	39·2	19	15·2	66·2	34	27·2	93·2
4 4/9	3 5/9	40	19 4/9	15 5/9	67	34 4/9	27 5/9	94

C.	R.	F.	C.	R.	F.	C.	R.	F.
35	28	95	50	40	122	65	52	149
35 5/9	28 4/9	96	50 5/9	40 4/9	123	65 5/9	52 4/9	150
36	28·8	96·8	51	40·8	122·8	66	52·8	150·8
36 1/9	28 8/9	97	51 1/9	40 8/9	124	66 1/9	52 8/9	151
36·25	29	97·25	51·25	41	124·25	66·25	53	151·25
36 2/3	29 1/3	98	51 2/3	41 1/3	125	66 2/3	53 1/3	152
37	29·6	98·6	52	41·6	125·6	67	53·6	152·6
37 2/9	29 7/9	99	52 2/9	41 7/9	126	67 2/9	53 7/9	153
37·5	30	99·5	52·5	42	126·5	67·5	54	153·5
37 7/9	30 2/9	100	52 7/9	42 2/9	127	67 7/9	54 2/9	154
38	30·4	100·4	53	42·4	127·4	68	54·4	154·4
38 1/3	30 2/3	101	53 1/3	42 2/3	128	68 1/3	54 2/3	155
38·75	31	101·75	53·75	43	128·75	68·75	55	155·75
38 8/9	31 1/9	102	53 8/9	43 1/9	129	68 8/9	55 1/9	156
39	31·2	102·2	54	43·2	129·2	69	55·2	156·2
39 4/9	31 5/9	103	54 4/9	43 5/9	130	69 4/9	55 5/9	157
40	32	104	55	44	131	70	56	158
40 5/9	32 4/9	105	55 5/9	44 4/9	132	70 5/9	56 4/9	159
41	32·8	105·8	56	44·8	132·8	71	56·8	159·8
41 1/9	32 8/9	106	56 1/9	44 8/9	133	71 1/9	56 8/9	160
41·25	33	106·25	56·25	45	133·25	71·25	57	160·25
41 2/3	33 1/3	107	56 2/3	45 1/3	134	71 2/3	57 1/3	161
42	33·6	107·6	57	45·6	134·6	72	57·6	161·6
42 2/9	33 7/9	108	57 2/9	45 7/9	135	72 2/9	57 7/9	162
42·5	34	108·5	57·5	46	135·5	72·5	58	162·5
42 7/9	34 2/9	109	57 7/9	46 2/9	136	72 7/9	58 2/9	163
43	34·4	109·4	58	46·4	136·4	73	58·4	163·4
43 1/3	34 2/3	110	58 1/3	46 2/3	137	73 1/3	58 2/3	164
43·75	35	110·75	58·75	47	137·75	73·75	59	164·75
43 8/9	35 1/9	111	58 8/9	47 1/9	138	73 8/9	59 1/9	165
44	35·2	111·2	59	47·2	138·2	74	59·2	165·2
44 4/9	35 5/9	112	59 4/9	47 5/9	139	74 4/9	59 5/9	166
45	36	113	60	48	140	75	60	167
45 5/9	36 4/9	114	60 5/9	48 4/9	141	75 5/9	60 4/9	168
46	36·8	114·8	61	48·8	141·8	76	60·8	168·8
46 1/9	36 8/9	115	61 1/9	48 8/9	142	76 1/9	60 8/9	169
46·25	37	115·25	61·25	49	142·25	76·25	61	169·25
46 2/3	37 1/3	116	61 2/3	49 1/3	143	76 2/3	61 1/3	170
47	37·6	116·6	62	49·6	143·6	77	61·6	170·6
47 2/9	37 7/9	117	62 2/9	49 7/9	144	77 2/9	61 7/9	171
47·5	38	117·5	62·5	50	144·5	77·5	62	171·5
47 7/9	38 2/9	118	62 7/9	50 2/9	145	77 7/9	62 2/9	172
48	38·4	118·4	63	50·4	145·4	78	62·4	172·4
48 1/3	38 2/3	119	63 1/3	50 2/3	146	78 1/3	62 2/3	173
48·75	39	119·75	63·75	51	146·75	78·75	63	173·75
48 8/9	39 1/9	120	63 8/9	51 1/9	147	78 8/9	63 1/9	174
49	39·2	120·2	64	51·2	147·2	79	63·2	174·2
49 4/9	39 5/9	121	64 4/9	51 5/9	148	79 4/9	63 5/9	175

C.	R.	F.	C.	R.	F.	C.	R.	F.
80	64	176	95	76	203	110	88	230
$80\frac{5}{9}$	$64\frac{4}{9}$	177	$95\frac{5}{9}$	$76\frac{4}{9}$	204	$110\frac{5}{9}$	$88\frac{4}{9}$	231
81	64·8	177·8	96	76·8	204·8	111	88·8	231·8
$81\frac{1}{9}$	$64\frac{8}{9}$	178	$96\frac{1}{9}$	$76\frac{8}{9}$	205	$111\frac{1}{9}$	$88\frac{8}{9}$	232
81·25	65	178·25	96·25	77	205·25	111·25	89	232·25
$81\frac{2}{3}$	$65\frac{1}{3}$	179	$96\frac{2}{3}$	$77\frac{1}{3}$	206	$111\frac{2}{3}$	$89\frac{1}{3}$	233
82	65·6	179·6	97	77·6	206·6	112	89·6	233·6
$82\frac{2}{9}$	$65\frac{7}{9}$	180	$97\frac{2}{9}$	$77\frac{7}{9}$	207	$112\frac{2}{9}$	$89\frac{7}{9}$	234
82·5	66	180·5	97·5	78	207·5	112·5	90	234·5
$82\frac{7}{9}$	$66\frac{2}{9}$	181	$97\frac{7}{9}$	$78\frac{2}{9}$	208	$112\frac{7}{9}$	$90\frac{2}{9}$	235
83	66·4	181·4	98	78·4	208·4	113	90·4	235·4
$83\frac{1}{3}$	$66\frac{2}{3}$	182	$98\frac{1}{3}$	$78\frac{2}{3}$	209	$113\frac{1}{3}$	$90\frac{2}{3}$	236
83·75	67	182·75	98·75	79	209·75	113·75	91	236·75
$83\frac{8}{9}$	$67\frac{1}{9}$	183	$98\frac{8}{9}$	$79\frac{1}{9}$	210	$113\frac{8}{9}$	$91\frac{1}{9}$	237
84	67·2	183·2	99	79·2	210·2	114	91·2	237·2
$84\frac{4}{9}$	$67\frac{5}{9}$	184	$99\frac{4}{9}$	$79\frac{5}{9}$	211	$114\frac{4}{9}$	$91\frac{5}{9}$	238
85	68	185	100	80	212	115	92	239
$85\frac{5}{9}$	$68\frac{4}{9}$	186	$100\frac{5}{9}$	$80\frac{4}{9}$	213	$115\frac{5}{9}$	$92\frac{4}{9}$	240
86	68·8	186·8	101	80·8	213·8	116	92·8	240·8
$86\frac{1}{9}$	$68\frac{8}{9}$	187	$101\frac{1}{9}$	$80\frac{8}{9}$	214	$116\frac{1}{9}$	$92\frac{8}{9}$	241
86·25	69	187·25	101·25	81	214·25	116·25	93	241·25
$86\frac{2}{3}$	$69\frac{1}{3}$	188	$101\frac{2}{3}$	$81\frac{1}{3}$	215	$116\frac{2}{3}$	$93\frac{1}{3}$	242
87	69·6	188·6	102	81·6	215·6	117	93·6	242·6
$87\frac{2}{9}$	$69\frac{7}{9}$	189	$102\frac{2}{9}$	$81\frac{7}{9}$	216	$117\frac{2}{9}$	$93\frac{7}{9}$	243
87·5	70	189·5	102·5	82	216·5	117·5	94	243·5
$87\frac{7}{9}$	$70\frac{2}{9}$	190	$102\frac{7}{9}$	$82\frac{2}{9}$	217	$117\frac{7}{9}$	$94\frac{2}{9}$	244
88	70·4	190·4	103	82·4	217·4	118	94·4	244·4
$88\frac{1}{3}$	$70\frac{2}{3}$	191	$103\frac{1}{3}$	$82\frac{2}{3}$	218	$118\frac{1}{3}$	$94\frac{2}{3}$	245
88·75	71	191·75	103·75	83	218·75	118·75	95	245·75
$88\frac{8}{9}$	$71\frac{1}{9}$	192	$103\frac{8}{9}$	$83\frac{1}{9}$	219	$118\frac{8}{9}$	$95\frac{1}{9}$	246
89	71·2	192·2	104	83·2	219·2	119	95·2	246·2
$89\frac{4}{9}$	$71\frac{5}{9}$	193	$104\frac{4}{9}$	$83\frac{5}{9}$	220	$119\frac{4}{9}$	$95\frac{5}{9}$	247
90	72	194	105	84	221	120	96	248
$90\frac{5}{9}$	$72\frac{4}{9}$	195	$105\frac{5}{9}$	$84\frac{4}{9}$	222	$120\frac{5}{9}$	$96\frac{4}{9}$	249
91	72·8	193·8	106	84·8	222·8	121	96·8	249·8
$91\frac{1}{9}$	$72\frac{8}{9}$	196	$106\frac{1}{9}$	$84\frac{8}{9}$	223	$121\frac{1}{9}$	$96\frac{8}{9}$	250
91·25	73	196·25	106·25	85	223·25	121·25	97	250·25
$91\frac{2}{3}$	$73\frac{1}{3}$	197	$106\frac{2}{3}$	$85\frac{1}{3}$	224	$121\frac{2}{3}$	$97\frac{1}{3}$	251
92	73·6	197·6	107	85·6	224·6	122	97·6	251·6
$92\frac{2}{9}$	$73\frac{7}{9}$	198	$107\frac{2}{9}$	$85\frac{7}{9}$	225	$122\frac{2}{9}$	$97\frac{7}{9}$	252
92·5	74	198·5	107·5	86	225·5	122·5	98	252·5
$92\frac{7}{9}$	$74\frac{2}{9}$	199	$107\frac{7}{9}$	$86\frac{2}{9}$	226	$122\frac{7}{9}$	$98\frac{2}{9}$	253
93	74·4	199·4	108	86·4	226·4	123	98·4	253·4
$93\frac{1}{3}$	$74\frac{2}{3}$	200	$108\frac{1}{3}$	$86\frac{2}{3}$	227	$123\frac{1}{3}$	$98\frac{2}{3}$	254
93·75	75	200·75	108·75	87	227·75	123·75	99	254·75
$93\frac{8}{9}$	$75\frac{1}{9}$	201	$108\frac{8}{9}$	$87\frac{1}{9}$	228	$123\frac{8}{9}$	$99\frac{1}{9}$	255
94	75·2	201·2	109	87·2	228·2	124	99·2	255·2
$94\frac{4}{9}$	$75\frac{5}{9}$	202	$109\frac{4}{9}$	$87\frac{5}{9}$	229	$124\frac{4}{9}$	$99\frac{5}{9}$	256

C.	R.	F.	C.	R.	F.	C.	R.	F.
125	100	257	140	112	284	155	124	311
125 5/9	100 4/9	258	140 5/9	112 4/9	285	155 5/9	124 4/9	312
126	100·8	258·8	141	112·8	285·8	156	124·8	312·8
126 1/9	100 8/9	259	141 1/9	112 8/9	286	156 1/9	124 8/9	313
126·25	101	259·25	141·25	113	286·25	156·25	125	313·25
126 2/3	101 1/3	260	141 2/3	113 1/3	287	156 2/3	125 1/3	314
127	101·6	260·6	142	113·6	287·6	157	125·6	314·6
127 2/9	101 7/9	261	142 2/9	113 7/9	288	157 2/9	125 7/9	315
127·5	102	261·5	142·5	114	288·5	157·5	126	315·5
127 7/9	102 2/9	262	142 7/9	114 2/9	289	157 7/9	126 2/9	316
128	102·4	262·4	143	114·4	289·4	158	126·4	316·4
128 1/3	102 2/3	263	143 1/3	114 2/3	290	158 1/3	126 2/3	317
128·75	103	263·75	143·75	115	290·75	158·75	127	317·57
128 8/9	103 1/9	264	143 8/9	115 1/9	291	159 8/9	127 1/9	318
129	103·2	264·2	144	115·2	291·2	159	127·2	318·2
129 4/9	103 5/9	265	144 4/9	115 5/9	292	159 4/9	127 5/9	319
130	104	266	145	116	293	160	128	320
130 5/9	104 4/9	267	145 5/9	116 4/9	294	160 5/9	128 4/9	321
131	104·8	267·8	146	116·8	294·8	161	128·8	321·8
131 1/9	104 8/9	268	146 1/9	116 8/9	295	161 1/9	128 8/9	322
131·25	105	268·25	146·25	117	295·25	161·25	129	322·25
131 2/3	105 1/3	269	146 2/3	117 1/3	296	161 2/3	129 1/3	323
132	105·6	269·6	147	117·6	296·6	162	129·6	323·6
132 2/9	105 7/9	270	147 2/9	117 7/9	297	162 2/9	129 7/9	324
132·5	106	270·5	147·5	118	297·5	162·5	130	324·5
132 7/9	106 2/9	271	147 7/9	118 2/9	298	162 7/9	130 2/9	325
133	106·4	271·4	148	118·4	298·4	163	130·4	325·4
133 1/3	106 2/3	272	148 1/3	118 2/3	299	163 1/3	130 2/3	326
133·75	107	272·75	148·75	119	299·75	163·75	131	326·75
133 8/9	107 1/9	273	148 8/9	119 1/9	300	163 8/9	131 1/9	327
134	107·2	273 2	149	119·2	300·2	164	131·2	327·2
134 4/9	107 5/9	274	149 4/9	119 5/9	301	164 4/9	131 5/9	328
135	108	275	150	120	302	165	132	329
135 5/9	108 4/9	276	150 5/9	120 4/9	303	165 5/9	132 4/9	330
136	108·8	276·8	151	120·8	303·8	166	132·8	330·8
136 1/9	108 8/9	277	151 1/9	120 8/9	304	166 1/9	132 8/9	331
136·25	109	277·25	151·25	121	304·25	166·25	133	331·25
136 2/3	109 1/3	278	151 2/3	121 1/3	305	166 2/3	133 1/3	332
137	109·6	278·6	152	121·6	305·6	167	133·6	332·6
137 2/9	109 7/9	279	152 2/9	121 7/9	306	167 2/9	133 7/9	333
137·5	110	279·5	152·5	122	306·5	167·5	134	333·5
137 7/9	110 2/9	280	152 7/9	122 2/9	307	167 7/9	134 2/9	334
138	110·4	280·4	153	122·4	307·4	168	134 4	334·4
138 1/3	110 2/3	281	153 1/3	122 2/3	308	168 1/3	134 2/3	235
138·75	111	281·75	153·75	123	308·75	168·75	135	335·75
138 8/9	111 1/9	282	153 8/9	123 1/9	309	168 8/9	135 1/9	336
139	111·2	282·2	154	123·2	309·2	169	135·2	336·2
139 4/9	111 5/9	283	154 4/9	123 5/9	310	169 4/9	135 5/9	337

C.	R.	F.	C.	R.	F.	C.	R.	F.
170	136	338	185	148	365	200	160	392
170 5/9	136 4/9	339	185 5/9	148 4/9	366	200 5/9	160 4/9	393
171	136·8	339·8	186	148·8	366·8	201	160·8	383·8
171 1/9	136·8/9	340	186 1/9	148 8/9	367	201 1/9	160 8/9	394
171·25	137	340·25	186·25	149	367·25	201·25	161	394·25
171 2/3	137 1/3	341	186 2/3	149 1/3	368	201 2/3	161 2/3	395
172	137·6	341·6	187	149·6	368·6	202	161·6	395·6
172 2/9	137 7/9	342	187 2/9	149 7/9	369	202 2/9	161 7/9	396
172·5	138	342·5	187·5	150	369·5	202·5	162	396·5
172 7/9	138 2/9	343	187 7/9	150 2/9	370	202 7/9	162 2/9	397
173	138·4	343·4	188	150·4	370·4	203	162·4	397·4
173 1/3	138 2/3	344	188 1/3	150 2/3	371	203 1/3	162 2/3	398
173·75	139	344·75	188·75	151	371·75	203·75	163	398·75
173 8/9	139 1/9	345	188 8/9	151 1/9	372	203 8/9	163 1/9	399
174	139·2	345·2	189	151·2	372·2	204	163·2	399·2
174 4/9	139 5/9	346	189 4/9	151 5/9	373	204 4/9	163 5/9	400
175	140	347	190	152	374	205	164	401
175 5/9	140 4/9	348	190 5/9	152 4/9	375	205 5/9	164 4/9	402
176	140·8	348·8	191	152·8	375·8	206	164·8	402·8
176 1/9	140 8/9	349	191 1/9	152 8/9	376	206 1/9	164 8/9	403
176·25	141	349·25	191·25	153	376·25	206·25	165	403·25
176 2/3	141 1/3	350	191 2/3	153 1/3	377	206 2/3	165 1/3	404
177	141·6	350·6	192	153·6	377·6	207	165·6	404·6
177 2/9	141 7/9	351	192 2/9	153 7/9	378	207 2/9	165 7/9	405
177·5	142	351·5	192·5	154	378·5	207·5	166	405·5
177 7/9	142 2/9	352	192 7/9	154 2/9	379	207 7/9	166 2/9	406
178	142·4	352·4	193	154·4	379·4	208	166·4	406·4
178 1/3	142 2/3	353	193 1/3	154 2/3	380	208 1/3	166 2/3	407
178·75	143	353·75	193·75	155	380·75	208·75	167	407·75
178 8/9	143 1/9	354	193 8/9	155 1/9	381	208 8/9	167 1/9	408
179	143·2	354·2	194	155·2	381·2	209	167·2	408·2
179 4/9	143 5/9	355	194 4/9	155 5/9	382	209 4/9	167 5/9	409
180	144	356	195	156	383	210	168	410
180 5/9	144 4/9	357	195 5/9	156 4/9	384	210 5/9	168 4/9	411
181	144·8	357·8	196	156·8	384·8	211	168·8	411·8
181 1/9	144 8/9	358	196 1/9	156 8/9	385	211 1/9	168 8/9	412
181·25	145	358·25	196·25	157	385·25	211·25	169	412·25
181 2/3	145 1/3	359	196 2/3	157 1/3	386	211 2/3	169 1/3	413
182	145·6	359·6	197	157·6	386·6	212	169·6	413·6
182 2/9	145 7/9	360	197 2/9	157 7/9	387	212 2/9	169 7/9	414
182·5	146	360·	197·5	158	387·5	212·5	170	414·5
182 7/9	146 2/9	361	197 7/9	158 2/9	388	212 7/9	170 2/9	415
183	146·4	361·4	198	158·4	388·4	213	170·4	415·4
183 1/3	146 2/3	362	198 1/3	158 2/3	389	213 1/3	170 2/3	416
183·75	147	362·75	198·75	159	389·75	213·75	171	416·75
183 8/9	147 1/9	363	198 8/9	159 1/9	390	213 8/9	171 1/9	417
184	147·2	363·2	199	159·2	390·2	214	171·2	417·2
184 4/9	147 5/9	364	199 4/9	159 5/9	391	214 4/9	171 5/9	418

C.	R.	F.	C.	R.	F.	C.	R.	F.
215	172	419	230	184	446	245	196	473
215 5/9	172 4/9	420	230 5/9	184 4/9	447	245 5/9	196 4/9	474
216	172·8	420·8	231	184·8	447·8	246	196·8	474·8
216 1/9	172 8/9	421	231 1/9	184 8/9	448	246 1/9	196 8/9	475
216·25	173	421·25	231·25	185	448·25	246·25	197	475·25
216 2/3	173 1/3	422	231 2/3	185 1/3	449	246 2/3	197 1/3	476
217	173·6	422·6	232	185·6	449·6	247	197·6	476·6
217 2/9	173 7/9	423	232 2/9	185 7/9	450	247 2/9	197 7/9	477
217·5	174	423·5	232·5	186	450·5	247·5	198	477·5
217 7/9	174 2/9	424	232 7/9	186 2/9	451	247 7/9	198 2/9	478
218	174·4	424·4	233	186·4	451·4	248	198·4	478·4
218 1/3	174 2/3	425	233 1/3	186 2/3	452	248 1/3	198 2/3	479
218·75	175	425·75	233·75	187	452·75	248·75	199	479·75
218 8/9	175 1/9	426	233 8/9	187 1/9	453	248 8/9	199 1/9	480
219	175·2	426·2	234	187·2	453·2	249	199·2	480·2
219 4/9	175 5/9	427	234 4/9	187 5/9	454	249 4/9	199 5/9	481
220	176	428	235	188	455	250	200	482
220 5/9	176 4/9	429	235 5/9	188 4/9	456	250 5/9	200 4/9	483
221	176·8	429·8	236	188·8	456·8	251	200·8	483·8
221 1/9	176 8/9	430	236 1/9	188 8/9	457	251 1/9	200 8/9	484
221·25	177	430·25	236·25	189	457·25	251·25	201	484·25
221 2/3	177 1/3	431	236 2/3	189 1/3	458	251 2/3	201 1/3	485
222	177·6	431·6	237	189·6	458·6	252	201·6	485·6
222 2/9	177 7/9	432	237 2/9	189 7/9	459	252 2/9	201 7/9	486
222·5	178	432·5	237·5	190	459·5	252·5	202	486·5
222 7/9	178 2/9	433	237 7/9	190 2/9	460	252 7/9	202 2/9	487
223	178·4	433·4	238	190·4	460·4	253	202·4	487·4
223 1/3	178 2/3	434	238 1/3	190 2/3	461	253 1/3	202 2/3	488
223·75	179	434·75	238·75	191	461·75	253·75	203	488·75
223 8/9	179 1/9	435	238 8/9	191 1/9	462	253 8/9	203 1/9	489
224	179·2	435·2	239	191·2	462·2	254	203·2	489·2
224 4/9	179 5/9	436	239 4/9	191 5/9	463	254 4/9	203 5/9	490
225	180	437	240	192	464	255	204	491
225 5/9	180 4/9	438	240 5/9	192 4/9	465	255 5/9	204 4/9	492
226	180·8	438·8	241	192·8	465·8	256	204·8	492·8
226 1/9	180 8/9	439	241 1/9	192 8/9	466	256 1/9	204 8/9	493
226·25	181	439·25	241·25	193	466·25	256·25	205	493·25
226 2/3	181 1/3	440	241 2/3	193 1/3	467	256 2/3	205 1/3	494
227	181·6	440·6	242	193·6	467·6	257	205·6	494·6
227 2/9	181 7/9	441	242 2/9	193 7/9	468	257 2/9	205 7/9	495
227·5	182	441·5	242·5	194	468·5	257·5	206	495·5
227 7/9	182 2/9	442	242 7/9	194 2/9	469	257 7/9	206 2/9	496
228	182·4	442·4	243	194·4	469·4	258	206·4	496·4
228 1/3	182 2/3	443	243 1/3	194 2/3	470	258 1/3	206 2/3	497
228·75	183	443·75	243·75	195	470·75	258·75	207	497·75
228 8/9	183 1/9	444	243 8/9	195 1/9	471	258 8/9	207 1/9	498
229	183·2	444·2	244	195·2	471·2	259	207·2	498·2
229 4/9	183 5/9	445	244 4/9	195 5/9	472	259 4/9	207 5/9	499

C.	R.	F.	C.	R.	F.	C.	R.	F.
260	208	500	275	220	527	290	232	554
260 5/9	208 4/9	501	275 5/9	220 4/9	528	290 5/9	232 4/9	555
261	208·8	501·8	276	220·8	528·8	291	232·8	555·8
261 1/9	208 8/9	502	276 1/9	220 8/9	529	291 1/9	232 8/9	556
261·25	209	502·25	276·25	221	529·25	291·25	233	556·25
261 2/3	209 1/3	503	276 2/3	221 1/3	530	291 2/3	233 1/3	557
262	209·6	503·6	277	221·6	530·6	292	233·6	557·6
262 2/9	209 7/9	504	277 2/9	221 7/9	531	292 2/9	233 7/9	558
262·5	210	504·5	277·5	222	531·5	292·5	234	558·5
262 7/9	210 2/9	505	277 7/9	222 2/9	532	292 7/9	234 2/9	559
263	210·4	505·4	278	222·4	532·4	293	234·4	559·4
263 1/3	210 2/3	506	278 1/3	222 2/3	533	293 1/3	234 2/3	560
263·75	211	506·75	278·75	223	533·75	293·75	235	560·75
263 8/9	211 1/9	507	278 8/9	223 1/9	534	293 8/9	235 1/9	561
264	211·2	507·2	279	223·2	534·2	294	235·2	561·2
264 4/9	211 5/9	508	279 4/9	223 5/9	535	294 4/9	235 5/9	562
265	212	509	280	224	536	295	236	563
265 5/9	212 4/9	510	280 5/9	224 4/9	537	295 5/9	236 4/9	564
266	212·8	510·8	281	224·8	537·8	296	236·8	564·8
266 1/9	212 8/9	511	281 1/9	224 8/9	538	296 1/9	236 8/9	565
266·25	213	511·25	281·25	225	538·25	296·25	237	565·25
266 2/3	213 1/3	512	281 2/3	225 1/3	539	296 2/3	237 1/3	566
267	213·6	512·6	282	225·6	539·6	297	237·6	566·6
267 2/9	213 7/9	513	282 2/9	225 7/9	540	297 2/9	237 7/9	567
267·5	214	513·5	282·5	226	540·5	297·5	238	567·5
267 7/9	214 2/9	514	282 7/9	226 2/9	541	297 7/9	238 2/9	568
268	214·4	514·4	283	226·4	541·4	298	238 4	568·4
268 1/3	214 2/3	515	283 1/3	226 2/3	542	298 1/3	238 2/3	569
268·75	215	515·75	283·75	227	545·75	298·75	239	569·75
268 8/9	215 1/9	516	283 8/9	227 1/9	543	298 8/9	239 1/9	570
269	215·2	216·2	284	227·2	543·2	299	239·2	571·2
269 4/9	215 5/9	517	284 4/9	227 5/9	544	299 4/9	239 5/9	571
270	216	518	285	228	545	300	240	572
270 5/9	216 4/9	519	285 5/9	228 4/9	546	300 5/9	240 4/9	573
271	216·8	519·8	286	228·8	546·8	301	240·8	573·8
271 1/9	216 8/9	520	286 1/9	228 8/9	547	301 1/9	240 8/9	574
271·25	217	520·25	286·25	229	547·25	301·25	241	574·25
271 2/3	217 1/3	521	286 2/3	229 1/3	548	301 2/3	241 1/3	575
272	217·6	521·6	287	229·6	548·6	302	241·6	575·6
272 2/9	217 7/9	522	287 2/9	229 7/9	549	302 2/9	241 7/9	576
272·5	218	522·5	287·5	230	549·5	302·5	242	576·5
272 7/9	218 2/9	523	287 7/9	230 2/9	550	302 7/9	242 2/9	577
273	218·4	523·4	288	230·4	550·4	303	242·4	577·4
273 1/3	218 2/3	524	288 1/3	230 2/3	551	303 1/3	242 2/3	578
273·75	219	524·75	288·75	231	551·75	303·75	243	578·75
273 8/9	219 1/9	525	288 8/9	231 1/9	552	303 8/9	243 1/9	579
274	219·2	525·2	289	231·2	552·2	304	243·2	579·2
274 4/9	219 5/9	526	289 4/9	231 5/9	553	304 4/9	243 5/9	580

C.	R.	F.	C.	R.	F.	C.	R.	F.
305	244	581	320	256	608	335	268	635
305 5/9	244 4/9	582	320 5/9	256 4/9	609	335 5/9	268 4/9	636
306	244·8	582·8	321	256·8	609·8	336	268·8	636·8
306 1/9	244 8/9	583	321 1/9	256 8/9	610	336 1/9	268 8/9	637
306·25	245	583·25	321·25	257	610·25	336·25	269	637·25
306 2/3	245 1/3	584	321 2/3	257 1/3	611	336 2/3	269 1/3	638
307	245·6	584·6	322	257·6	611·6	337	269·6	638·6
307 2/9	245 7/9	585	322 2/9	257 7/9	612	337 2/9	269 7/9	639
307·5	246	585·5	322·5	258	612·5	337·5	270	639·5
307 7/9	246 2/9	586	322 7/9	258 2/9	613	337 7/9	270 2/9	640
308	246·4	586·4	323	258·4	613·4	338	270·4	640·4
308 1/3	246 2/3	587	323 1/3	258 2/3	614	338 1/3	270 2/3	641
308·75	247	587·75	323·75	259	614·75	338·75	271	641·75
308 8/9	247 1/9	588	323 8/9	259 1/9	615	338 8/9	271 1/9	642
309	247·2	588·2	324	259·2	615·5	339	271·2	642·2
309 4/9	247 5/9	589	324 4/9	259 5/9	616	339 4/9	271 5/9	643
310	248	590	325	260	617	340	272	644
310 5/9	248 4/9	591	325 5/9	260 4/9	618	340 5/9	272 4/9	645
311	248·8	591·8	326	260·8	618·8	341	272·8	645·8
311 1/9	248 8/9	592	326 1/9	260 8/9	619	341 1/9	272 8/9	646
311·25	249	592·25	326·25	261	619·25	341·25	273	646·25
311 2/3	249 1/3	593	326 2/3	261 1/3	620	341 2/3	273 1/3	647
312	249·6	593·6	327	261·6	620·6	342	273·6	647·6
312 2/9	249 7/9	594	327 2/9	261 7/9	621	342 2/9	273 7/9	648
312·5	250	594·5	327·5	262	621·5	342·5	274	648·5
312 7/9	250 2/9	595	327 7/9	262 2/9	622	343 7/9	274 2/9	649
313	250·4	595·4	328	262·4	622·4	343	274·4	649·4
313 1/3	250 2/3	596	328 1/3	262 2/3	623	343 1/3	274 2/3	650
313·75	251	596·75	328·75	263	623·75	343·75	275	650·75
313 8/9	251 1/9	597	328 8/9	263 1/9	624	343 8/9	275 1/9	651
314	251·2	597·2	329	263·2	624·2	344	275·2	651·2
314 4/9	251 5/9	598	329 4/9	263 5/9	625	344 4/9	275 5/9	652
315	252	599	330	264	626	345	276	653
315 5/9	252 4/9	600	330 5/9	264 4/9	627	345 5/9	276 4/9	654
316	252·8	600·8	331	264·8	627·8	346	276·8	654·8
316 1/9	252 8/9	601	331 1/9	264 8/9	628	346 1/9	276 8/9	655
316·25	253	601·25	331·25	265	628·25	346·25	277	655·25
316 2/3	253 1/3	602	331 2/3	265 1/3	629	346 2/3	277 1/3	656
317	253·6	602·6	332	265·6	629·6	347	277·6	656·6
317 2/9	253 7/9	603	332 2/9	265 7/9	630	347 2/9	277 7/9	657
317·5	254	603·5	332·5	266	630·5	347·5	278	657·5
317 7/9	254 2/9	604	332 7/9	266 2/9	631	347 7/9	278 2/9	658
318	254·4	604·4	333	266·4	631·4	348	278·4	658·4
318 1/3	254 2/3	605	333 1/3	266 2/3	632	348 1/3	278 2/3	659
318·75	255	605·75	333·75	267	632·75	348·75	279	659·75
318 8/9	255 1/9	606	333 8/9	267 1/9	633	348 8/9	279 1/9	660
319	255·2	606·2	334	267·2	633·2	349	279·2	660·2
319 4/9	255 5/9	607	334 4/9	267 5/9	634	349 4/9	279 5/9	661

C.	R.	F.	C.	R.	F.	C.	R.	F.
350	280	662	353 1/3	282 2/3	668	357	285·6	674·6
350 5/9	280 4/9	663	353·75	283	668·75	357 2/9	285 7/9	675
351	280·8	663·8	353 8/9	283 1/9	669	357·5	286	675·5
351 1/9	280 8/9	664	354	283·2	669·2	357 7/9	286 2/9	676
351·25	281	664·25	354 4/9	283 5/9	670	358	286·4	676·4
351 2/3	281 1/3	665	355	284	671	358 1/3	286 2/3	677
352	281·6	665·6	354 5/9	284 4/9	672	358·75	287	677·75
352 2/9	281 7/9	666	356	284·8	672·8	358 8/9	287 1/9	678
352·5	282	666·5	356 1/9	284 8/9	673	359	287·2	678·2
352 7/9	282 2/9	667	356·25	285	673·25	359 4/9	287 5/9	679
353	282·4	667·4	356 2/3	285 1/3	674	360	288	680

AUXILIARY TABLE

FOR THE COMPARISON OF HIGHER TEMPERATURES.

C.	R.	F. Directly.	F. By addition.	R.	C.	F. Directly.	F. By addition.	F.	Directly. C.	Directly. R.	By addition. C.	By addition. R.
400	320	752	720	300	375	707	675	700	371 1/9	296 8/9	388 8/9	311 1/9
500	400	932	900	400	500	932	900	800	426 2/3	341 1/3	444 4/9	355 5/9
600	480	1112	1080	500	625	1157	1125	900	482 2/9	385 7/9	500	400
700	560	1292	1260	600	750	1382	1350	1000	537 7/9	430 2/9	555 5/9	444 4/9
800	640	1472	1440	700	875	1607	1575	1100	593 1/3	474 2/3	611 1/9	488 8/9
900	720	1652	1620	800	1000	1832	1800	1200	648 8/9	519 1/9	666 2/3	533 1/3
1000	800	1832	1800	900	1125	2057	2025	1300	704 4/9	563 5/9	722 2/9	577 7/9
1100	880	2012	1980	1000	1250	2282	2250	1400	760	608	777 7/9	622 2/9
1200	960	2192	2160	1100	1375	2507	2475	1500	815 5/9	652 4/9	833 1/3	666 2/3
1300	1040	2372	2340	1200	1500	2732	2700	1600	871 1/9	696 8/9	888 8/9	711 1/9
1400	1120	2552	2520	1300	1625	2957	2925	1700	926 2/3	741 1/3	944 4/9	755 5/9
1500	1200	2732	2700	1400	1750	3182	3150	1800	982 2/9	785 7/9	1000	800
1600	1280	2912	2880	1500	1875	3407	3375	1900	1037 7/9	830 2/9	1055 5/9	844 4/9
								2000	1093 1/3	874 2/3	1111 1/9	888 8/9

EXPLANATION OF THE AUXILIARY TABLE.

By the aid of this table the three scales may be compared up to 1960° C., 1788° R., and 2680° F., (degrees not corresponding to the same temperature.)

The conversion of degrees, terminating in two zeros, are found in the columns headed "Directly," *e. g.*:

$$1100^0\ \text{C.} = 880^0\ \text{R.} = 2012^0\ \text{F.}$$
$$1500^0\ \text{F.} = 815\tfrac{5}{9}\ \text{C.} = 652\tfrac{4}{9}\ \text{R.}$$

On the other hand, the conversions of degrees, not terminating in two zeros, are contained in the columns headed "By addition."

In order to convert 1142^0 C. and 1536^0 F., respectively into F. degrees and R. degrees, we find:

In the auxiliary table .	1100^0 C. =	880^0 R. =	1980^0 F.
To which are added from the principal table .	42^0 C. =	$33{\cdot}6^0$ R. =	$107{\cdot}6^0$ F.
	1142^0 C. =	$913{\cdot}6^0$ R. =	$2087{\cdot}6^0$ C. F.

In the auxiliary table .	1500^0 F. =	$833\tfrac{1}{3}^0$ C. =	$666\tfrac{2}{3}^0$ R.
In the principal table .	36^0 F. =	$2\tfrac{2}{9}^0$ C. =	$1\tfrac{7}{9}^0$ R.
	1536^0 F. =	$835\tfrac{5}{9}^0$ C. =	$668\tfrac{4}{9}^0$ R.

For the sake of shortness, we have used in these tables, indiscriminately, vulgar and decimal fractions. We append a translation of the vulgar fractions occurring into decimal fractions:

$\frac{1}{9} = 0{\cdot}11111$	$\frac{1}{9} = 0{\cdot}7778$	$\frac{1}{3} = 0{\cdot}3333$
$\frac{2}{9} = 0{\cdot}2222$	$\frac{8}{9} = 0{\cdot}8889$	$\frac{2}{3} = 0{\cdot}6666$
$\frac{4}{9} = 0{\cdot}4444$		
$\frac{5}{9} = 0{\cdot}5556$		

MEASURES OF CAPACITY.

	In cubic inches.	In cubic feet = 1728 cubic inches.	In pints = 34·659 cubic inches.	In gallons = 8 pints = 277·274 cubic inches.	Bushels = 8 gallons = 2218·192 cubic inches.
0·01 cubic centimetre	0·000610	0·0000004	0·000018	0·00000220	0·0000003
0·1 cubic centimetre	0·006103	0·0000035	0·000176	0·00002201	0·0000027
Millilitre, or cubic centimetre . .	0·061027	0·0000353	0·001761	0·00022010	0·0000275
Centilitre, or 10 cubic centimetres	0·610271	0·0003532	0·017608	0·00220097	0·0002751
Decilitre, or 100 cubic centimetres	6.102711	0·0035317	0·176077	0·02200969	0·0027512
Litre, or cubic decimetre . . .	61·027112	0·0353166	1·760775	0·22009687	0·0275121
Decalitre, or centistère	610·271120	0·3531661	17·607749	2·20096870	0·2751211
Hectolitre, or decistère . . .	6102·711200	3·5316610	176·077496	22·00968700	2·7512109
Kilolitre, or stère, or cubic metre	61027·112000	35·3166100	1760·774960	220·09687000	27·5121090
Myriolitre, or decastère . . .	610271·120000	353·1661000	17607·749600	2220·96870000	275·1210900

MEASURES OF LENGTH.

	In English inches.	In English feet =12 inches.	In English yards =3 feet.	In English fathoms =6 feet.	In English miles =1760 yards.
0·01 millimetre	0·00039	0·0000328	0·0000109	0·0000055	——
0·1 millimetre	0·00394	0·0003281	0·0001094	0·0000547	——
Millimetre	0·03937	0·0032809	0·0010936	0·0005468	0·0000006
Centimetre	0·39371	0·0328090	0·0109363	0·0054682	0·0000062
Decimetre	3·93708	0·3280899	0·1093633	0·0546816	0·0000621
Metre	39·37079	3·2808992	1·0936331	0·5468165	0·0006214
Decametre	393·70790	32·8089920	10·9363310	5·4681655	0·0062138
Hectometre	3937·07900	328·0899200	109·3633100	54·6816550	0·0621382
Kilometre	39370·79000	3280·8992000	1093·6331000	546·8165500	0·6213824
Myriometre	393707·90000	32808·9920000	10936·3310000	5468·1655000	6·2138244

MEASURES OF WEIGHT.

	In English grains.	In troy pounds = 5760 grains.	In avoirdupois pounds = 7000 grains.	In cwts. = 112 lbs. = 784000 grains.	In tons = 20 cwts. = 15680000 grains.
0·01 milligramme . . .	0·000154	——	——	——	——
0.1 milligramme	0·001543	0·0000003	0·0000002	——	——
Milligramme	0·015434	0·0000027	0·0000022	0·00000002	——
Centigramme	0·154340	0·0000268	0·0000220	0·00000020	0·00000001
Decigramme	1·543400	0·0002679	0·0002205	0·00000197	0·00000010
Gramme	15·434000	0·0026795	0·0022049	0·00001969	0·00000098
Decagramme	154·340000	0·0267951	0·0220486	0·00019686	0·00000984
Hectogramme	1543·400000	0·2679514	0·2204857	0·00196862	0·00009843
Kilogramme	15434·000000	2·6795140	2·2048571	0·01968622	0·00098431
Myriogramme	154340·000000	26·7951400	22·0485710	0·19686223	0·00984311

SYMBOLS AND EQUIVALENTS ADOPTED IN THE ANNUAL REPORT.

Aluminum	Al	13·7	Molybdenum	Mo	46
Antimony	Sb	129	Niobium	Nb	
Arsenic	As	75	Nitrogen	N	14
Barium	Ba	68·5	Norium	No	
Beryllium	Be	4·7	Osmium	Os	99·6
Bismuth	Bi	213	Oxygen	O	8
Boron	B	10·9	Palladium	Pd	53·3
Bromine	Br	80	Pelopium	Pe	
Cadmium	Cd	56	Phosphorus	P	32
Calcium	Ca	20	Platinum	Pt	98·7
Carbon	C	6	Potassium	K	39·2
Cerium	Ce	47	Rhodium	R	52·2
Chlorine	Cl	35·5	Ruthenium	Ru	52·2
Chromium	Cr	26·7	Selenium	Se	39·5
Cobalt	Co	29·5	Silicium	Si	21·3
Copper	Cu	31·7	Silver	Ag	108·1
Didymium	D		Sodium	Na	23
Erbium	E		Strontium	Sr	43·8
Fluorine	Fl	18·9	Sulphur	S	16
Gold	Au	197	Tantalum	Ta	184
Hydrogen	H	1	Tellurium	Te	64·2
Iodine	I	127·1	Terbium	Tb	
Iridium	Ir	99	Thorium	Th	59·6
Iron	Fe	28	Tin	Sn	59
Lanthanium	La		Titanium	Ti	25
Lead	Pb	103·7	Tungsten	W	95
Lithium	Li	6·5	Uranium	U	60
Magnesium	Mg	12·2	Vanadium	V	68·6
Manganese	Mn	27·6	Yttrium	Y	
Mercury	Hg	100	Zinc	Zn	32·6
Nickel	Ni	29·6	Zirconium	Zr	22·4

N.B.—THE ATOMIC WEIGHTS AND EQUIVALENTS ARE ASSUMED TO BE EQUAL.

Abbreviations in the References.

The numbers in [brackets] indicate that the volume quoted belongs to a series (*série*, *Folge*) represented by such numbers.

Ann. Ch. Pharm.	sign. :	Annalen der Chemie und Pharmacie, herausgegeben von Wöhler und Liebig.—Heidelberg.
Ann. Ch. Phys.	„	Annales de chimie et de physique, par Gay-Lussac, Arago, Chevreul, Dumas, Pelouze, Boussingault et Regnault.—Paris.
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ABBREVIATIONS IN THE INDEX.

Act.	Action.
Anal.	Analysis.
Appl.	Application.
Boil. p.	Boiling-point.
Comb.	Combination.
Comp.	Compare.
Compos.	Composition.
Cond. r.	Conduction-resistance.
Const.	Constitution.
Cryst. f.	Crystalline form.
Decomp.	Decomposition.
Deport.	Deportment.
Determ.	Determination.
Detect.	Detection.
Electr.	Electricity.
Equiv.	Equivalent.
Exp.	Expansion.
Exam.	Examination.
Form.	Formation.
Fus. h.	Fusion-heat.
Fus. p.	Fusing point.
Invest.	Investigation.
Lat. fus. h.	Latent fusion-heat.
Lat. h.	Latent heat.
Lat. vap. h.	Latent vapour-heat.
Occur.	Occurrence.
Opt. deport.	Optical deportment.
Org. subst.	Organic substance.
Precip.	Precipitation.
Prod.	Product.
Prep.	Preparation.
Prop.	Properties.
Recogn.	Recognition.
Separ.	Separation.
Solut.	Solution.
Sol.	Soluble.
Spec. grav.	Specific gravity.
Spec. h.	Specific heat.
Subst.	Snbstance.
Temp.	Temperature.
Tens. of vap.	Tension of vapour.

END OF VOL. II.

LONDON:
Printed by Schulze and Co., 13, Poland Street.